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PHYSICS AND MATHEMATICS

No. 74

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UDC 534.26

PLANAR ACOUSTIC WAVE SCATTERING BY TWO IDEAL SPHERES

Minsk IZVESTIYA AKADEMII NUAK BSSR: SERIYA FIZIKO-MATEMATICHESKIKH NAUK
in Russian No 4, Jul-Aug 81 (manuscript received 3 Sep 80) pp 5-10

MARNEVSKAYA, L. A., Institute of Mathematics, BSSR Academy of Sciences

[Abstract] The author solves the problem of diffraction of a plane sound wave for two spheres when one is acoustically soft, and the other is acoustically hard. It is assumed that the spheres are located in an infinite homogeneous medium and have arbitrary given radii. The planar acoustic wave propagates from a source on the line joining the centers of the two spheres at a point midway between them in a direction at a given angle to this line. The potential of the scattered sound wave is found that satisfies the Helmholtz wave equation in the region outside of the spheres, boundary conditions on the surfaces of the spheres and the condition of radiation at infinity. The solution is found by separation of variables, giving infinite systems of linear equations with matrix elements in the second members. An asymptotic expression is used to find an approximation for the scattered field in the far zone. Computer-generated numerical solutions are given for the scattering intensity in the far zone in the case of two spheres of identical radius separated by different distances, and also for a fixed distance and fixed radius of one sphere as the radius of the other sphere is varied. Figures 4, references 4 Russian.
[18-6610]

SOUND DAMPING DUE TO DECAY OF COHERENT CONCENTRATION WAVES IN NIOBIUM-HYDROGEN SOLUTION

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 34, No 6, 20 Sep 81 (manuscript received 15 Jul 81) pp 338-341

MELIK-SHAKHNAZAROV, V. A., NASKIDASHVILI, I. A. and ARABADZHYAN, N. L.,
Institute of Physics, Georgian SSR Academy of Sciences

[Abstract] Previous research has shown that decay of metal-hydrogen solid solutions involves the formation of planar concentration waves on the macroscopic

scale with wavelength of the order of specimen dimensions, and on the microscopic scale with wavelength much smaller than specimen dimensions. Cold neutron scattering experiments on the stability limits of short-wave concentration waves in Nb-H solid solution have shown two spinodals lying below a temperature of 80 K corresponding to two orientations of the wave vector $\vec{k} \parallel [110]$ and $\vec{k} \parallel [111]$. In this paper the authors study damping of sound on about 1000 Hz in a solid solution of $NbH_{0.04}$ in the temperature range of 1.5-80 K that includes the temperatures of the two spinodals for the given composition. The specimens were plates measuring 10 x 3 x 0.3 mm in which the transverse 1/4-wave mode was excited. The measurements were done with an acoustic spectrometer working in the regenerative mode. Zone-melted polycrystal niobium was used. Hydrogen saturation was done at 850 K in a quartz vessel. Maxima in attenuation of sound were observed at 18 K and 55 K, which are the spinodal temperatures for the given composition, which means that the observed absorption maxima are due to loss of stability of the concentration waves polarized in directions [110] and [111]. An estimate of the coefficient of diffusion of hydrogen gives $D \gtrsim 10^{-11}$ cm^2/s at 20 K. Despite the high concentration of hydrogen, this coefficient of diffusion is 3-5 orders of magnitude higher than those determined by other methods. Figure 1, references 12: 5 Russian, 7 Western.
[36-6610]

UDC 534.833.53:532.872

SOUND PROPAGATION IN CRYSTALLIZING LIQUID

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 27, No 5, Sep-Oct 81
(manuscript received 20 May 81) pp 678-686

AKULICHEV, V. A. and BULANOV, V. N., Pacific Oceanological Institute,
USSR Academy of Sciences

[Abstract] An analysis is made of the propagation of sound in a crystallizing liquid with determination of the relative contributions of various mechanisms to excess absorption and dispersion of the speed of sound. An examination is also made of the influence that impurities have on sound propagation in a crystallizing liquid. It is shown that the absorption of sound in a crystallizing liquid is greater than that in a liquid with solid particles without phase transitions. This apparently explains the intensification of acoustic currents in crystallizing melts. The dispersion of the speed of sound in a crystallizing liquid is also anomalously high as compared with a liquid that contains solid particles without phase transformations. Experiments to confirm these effects should be done at fairly low sound frequencies, and at as high a volumetric concentration of solid phase as possible. Of particular interest would be a study of sound propagation in slush ice, since such a medium may have an appreciable effect on the conditions of propagation of acoustic signals in polar regions of the ocean. Figures 4, references 17: 15 Russian, 2 Western.
[30-6610]

UDC 681.883.67:534.232

MINIATURE HYDROACOUSTIC RECEIVERS BASED ON DISCRETE STRUCTURES

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 27, No 5, Sep-Oct 81
(manuscript received 30 Apr 80, after revision 19 Feb 81) pp 759-766

KONEVA, M. A., KRAVCHUN, P. N. and CHERNYSHEV, K. V., Moscow State University
imeni M. V. Lomonosov, Acoustics Department

[Abstract] The problem of making low-frequency transducers with dimensions smaller than a wavelength can be solved by using oscillatory systems with lumped parameters. One such design in hydroacoustics is a compound dipole in which the elasticity is provided by a piezoelectric element, while the mass takes the form of passive end plates on this element. In such a system, the resonant frequency can be lowered only by increasing the dimensions of the passive component. Another system that can be treated as a resonator with lumped mass and elasticity is based on utilizing resonance in a passive system of two transitional layers of small thickness. Such a system has small dimensions in the direction perpendicular to the working surface of the transducer, and can act as a single-frequency matching dipole. In this paper the authors stude a method of making miniature transducers that differ from conventional designs in using discrete (generally speaking multiple-link) structures in which the inertial elements are piezoactive. An increase in compliance of the elastic elements of such a structure without changing the mass of the active inertial elements or the overall dimensions can in principle arbitrarily reduce the velocity of wave propagation in the structure. The analysis is based on a model with two degrees of freedom made up of two components: the first is a reception plate of given mass and area with an elastic spring, and the second is a piezoelectric element of given mass and length and another elastic spring. The element has the longitudinal piezoelectric effect, and voltages are taken off at the plates. The characteristics for the reception mode are analyzed. Calculations of sensitivity are confirmed by experiments. Figures 4, references 7 Russian.
[30-6610]

UDC 533.599

ULTRAHIGH-VACUUM EQUIPMENT FOR COMPLEX STUDY OF SURFACES AND ULTRATHIN SOLID FILMS

Riga IZVESTIYA AKADEMII NAUK LATVIYSKOY SSR: SERIYA FIZICHESKIKH I TEKHNICHESKIKH NAUK in Russian No 4, Jul-Aug 81 (manuscript received 14 Jan 81) pp 122-125

BERGS, A. B., KALNACH, Ya. V., KVASKOV, L. V. and FELTYN', I. A., Physico-Energetics Institute, LaSSR Academy of Sciences

[Abstract] An ultrahigh-vacuum test stand has been developed suitable for complex studies of surfaces and ultrathin solid films, with facilities for adaptation of the equipment components to any specific task. It consists of three main functional parts: a transfer chamber where a vacuum of $(5-8)\cdot10^{-8}$ Pa can be attained within 30 min with the aid of two sorption pumps and one magnetic-discharge pump, for preparation of a specimen, a working chamber where the vacuum is initially $1\cdot10^{-7}$ Pa and can drop to $1\cdot10^{-8}$ Pa for processing and rough testing of a specimen, and the test chamber proper where the vacuum is at least 10^{-8} Pa. Auxiliary components include an ellipsometer chamber with an LEF-2 instrument, a sprayer chamber, an ion gun, an electron gun, a vacumeter probe, a mass-spectrometer probe, a set of metal-glass vacuum-sealed voltage (0-12 kV) and current (0-100 A) feeders, a gas feed line, a liquid-nitrogen feed line, a set of specimen manipulators, a set of inspection windows, and a set of irradiation windows made of quartz and sapphire. The ion gun produces ion beams with an energy of 100-600 eV and a density of 10^{-3} mA/m^2 under a gas pressure of 10^{-1} Pa. The electron gun with an accelerating voltage of 1-7 kV produces electron beams with a density of $4\cdot10^{-3}$ mA/m^2 for heating and cleaning a specimen. The working chamber is evacuated by means of two zeolite sorption pumps, a magnetic-discharge pump, and a titanium evaporation pump. The main advantages of this equipment are its universality, mobility and flexibility, also the possibility of shielding a specimen against atmospheric effects. Figures 2, references 4 Russian.
[25-2415]

UDC 53:51-539.216.2

USING ELLIPSOMETRY TO DETERMINE THICKNESS AND REFRACTIVE INDEX OF VERY THIN DIELECTRIC FILMS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 9, Sep 81
(manuscript received 22 Jul 80) pp 1928-1932

KRASIL'NIKOVA, Ye. V. and LEBEDEVA, V. N., Institute of Crystallography,
USSR Academy of Sciences, Moscow

[Abstract] A computer experiment is done on use of the least-squares method in the film and backing problem for thin films of water ($n = 1.3318$) on LiF backings ($n = 1.39119$) and on YAG backings ($n = 1.8305$) at wavelength $\lambda = 6328$ Å. First a solution was found for the direct problem: determining the parameters ψ and Δ from the Drude equation at known constants of the backing and film. The resultant pairs of "experimental" values ψ_i^e and Δ_i^e calculated at three angles of incidence ϕ_i were then used as initial data in solving the inverse problem: determining the parameters n and d of the film from the given ψ_i^e and Δ_i^e. An analysis of the way that the solution depends on the initial estimates of the unknown index of refraction and thickness of the water film, as well as analysis of the permissible errors in the experimental parameters ψ and Δ shows that simultaneous determination of n and d is possible for thin films down to about 10 Å thick when the refractive indices of film and backing are considerably different (water and garnet), but fails for close indices (water and LiF) at thicknesses of less than 40 Å. Figures 3, references 6: 3 Russian, 3 Western.
[20-6610]

EFFECT OF QUANTUM CORRECTIONS ON RESISTANCE OF THIN BISMUTH FILMS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 34, No 6, 20 Sep 81 (manuscript received 31 Jul 81) pp 367-371

SAVCHENKO, A. K., LUTSKIY, V. N. and RYLIK, A. S., Institute of Radio
Engineering and Electronics, USSR Academy of Sciences

[Abstract] Recent theoretical research has examined quantum corrections to the resistance of thin metal films. It has been shown that interference of electron waves when they are scattered by impurities leads to an anomalous rise in resistance as temperature falls (theory of "localization"). In an alternative theory (the theory of "interaction") an anlogous result comes from consideration of the interaction between electrons as they are scattered by impurities. Both theories give the same law of logarithmic increase in film resistance as the temperature decreases:

$$\frac{\Delta R_{\square}}{R_{\square}^2} = -\frac{\alpha p}{2} \frac{e^2}{\pi^2 \hbar} \ln T,$$

where $R_{\square}$ is the resistance of a film of square shape. In the theory of localization the parameter $\alpha \sim 1$, and the parameter p is determined by the mechanism of

inelastic scattering and lies in a range of 2-3. In the theory of interaction $\alpha p \sim 1$, and may be less than unity in the case of strong shielding. In studies of the effect of magnetic field on quantum corrections to conductivity the difference between the theories shows up in the way that anomalous magnetoresistance depends on the magnetic field: with the exception of a few specific situations, this dependence is negative for the theory of localization and positive for the theory of interaction. Some experiments show a logarithmic increase in the resistance of thin films of metals as T decreases, which can be attributed to localization of electrons. In other experiments, the predominant role of interaction between electrons in metal films is observed. In this paper the authors study the influence of quantum corrections on the resistance of thin films of bismuth produced by vacuum sputtering on mica at room temperature. Thicknesses ranged from 50 to 500 Å. Resistance was measured by a compensation method on alternating current at a frequency of 20 Hz, ensuring a sensitivity of 10^{-5}. The voltage across the specimens was about 1 mV. The results of measurements show logarithmic increase in resistance with decreasing temperature and logarithmic dependence of magnetoresistance on magnetic field. It is concluded that the observed behavior is due to predominant influence of effects of interelectron interaction. Figures 3, references 8: 5 Russian, 3 Western.
[36-6610]

SURFACE POLARITONS IN ION-IMPLANTED GALLIUM ARSENIDE

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 23, No 9, Sep 81
(manuscript received 23 Feb 81) pp 2630-2633

DMITRUK, N. L., LITOVCHENKO, V. G. and NIKOLAYEVA, T. N., Institute of Semiconductors, UkSSR Academy of Sciences, Kiev

[Abstract] An ATR technique is used to study the effect of Si^+-ion doping of semi-insulating GaAs. Implantation was with ions of 80-keV energy in doses of from $5 \cdot 10^{12}$ to 10^{13} cm^{-2}. Some of the specimens were annealed at 650-700°C without protective coatings to activate the dopant and anneal the defects introduced by implantation. The external-reflection and ATR spectra were measured in the region of lattice vibrations. The measurements were done on the IKS-21 spectrometer with ATR attachment based on a CsI dispersing element in the form of a semicylinder. The results are interpreted on the basis of a multilayer model of the reflecting system including the surface layer in which surface plasmon-phonon polaritons are localized. Analysis shows that the measurement of ATR spectra is a quite effective nondestructive method of ion-doped semiconductors (concentration and mobility of current carriers, frequency and attenuation of phonons). Figures 2, references 17: 10 Russian, 7 Western.
[35-6610]

ELECTRIC CONDUCTIVITY OF CESIUM IODIDE BEHIND SHOCK WAVE FRONT AT PRESSURES UP TO 100 GPa

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 23, No 9, Sep 81
(manuscript received 17 Dec 80, after revision 11 May 81) pp 2848-2851

GATILOV, L. A. and KULESHOVA, L. V.

[Abstract] One of the few currently accessible techniques for studying the state of matter at high pressures and temperatures is the measurement of electric conductivity of condensed media in shock waves. However, there have been procedural difficulties in measurement of electrical conductivity close to metallic in shock-compressed dielectrics. In this paper, the authors use a method that overcomes these difficulties [see L. A. Gatilov, L. V. Kuleshova, ZHURNAL PRIKLADNOY MEKHANIKI I TECHNICHESKOY FIZIKI, No 1, 1981, p 136] to measure the electrical conductivity of cesium iodide behind a shock wave front. The conductivity distribution was determined for CsI single crystals behind a planar steady-state shock wave front. It was found that conductivity increases from 10 to 10^5 mho/m as pressure rises from 20 to 100 GPa. Conductivity falls off with time of the CsI in the compressed state in the solid phase, and increases in the liquid phase. This behavior shows the nonequilibrium nature of CsI behind the shock wave front for times greater than the measurement time of about 0.5 μs. A qualitative interpretation of the experiment is given, based on the assumption of gradual conversion of CsI with increasing shock wave amplitude to an intrinsic-defect semiconductor, and subsequently to a liquid semiconductor and a liquid metal. Figure 1, references 16: 15 Russian, 1 Western. [35-6610]

UDC 621.315.592

DEFECTS PRODUCED BY SILICON ION IMPLANTATION IN p-SILICON CLOSE TO $Si-SiO_2$ INTERFACE

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 15, No 9, Sep 81
(manuscript received 4 Dec 80) pp 1755-1759

GALKIN, G. N., VAVILOV, V. S., ABBASOVA, R. U. and BOBROVA, Ye. A.,
Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] The method of capacitance-voltage curves of MDS structures is used to determine the position of deep levels created by implanting silicon ions in silicon close to the $Si-SiO_2$ interface through a layer of SiO_2. Curves are plotted for the defect concentration as a function of implantation dose and annealing temperature. Plates of thermally oxidized p-Si were used that were grown by the Czochralski method with resistivity of 15 Ω·cm and oxide thickness of 1100 A. Implantation of $^{30}Si^+$ ions with energy of 120 keV took place in the vicinity of the $Si-SiO_2$ interface. Ion doses were from 10^{11} to 10^{13} ions/cm^2. The specimens were annealed in argon from room temperature up to 510°C.

Measurement of capacitance-voltage characteristics showed deep levels due to implantation defects at E_c-0.25, E_c-0.4, E_c-0.52, E_v+0.44, E_v+0.38 and E_v+0.26 eV. The results show bimolecular annealing of the continuous background of the density of states on the Si-SiO_2 boundary. Figures 4, references 12: 3 Russian, 9 Western.
[31-6610]

UDC 621.315.592

EFFECTS ACCOMPANYING STRONG SOUND WAVE IN PIEZOELECTRIC SEMICONDUCTOR

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 15, No 9, Sep 81 (manuscript received 28 Dec 78, after revision 9 Feb 81) pp 1823-1826

CHERNOZATONSKIY, L. A.

[Abstract] When a strong acoustic wave propagates in a piezoelectric semiconductor in the region of wavelengths exceeding the effective mean free path of electrons, the electron density wave that accompanies the sound becomes nonsinusoidal due to strong concentrational nonlinearity. In this paper, three methods are considered for detecting the resultant harmonics: by Bragg scattering of light, non-collinear scattering of a weak sound wave, and by using an alternating electric field for "readout" and "storage." The first method is easiest for detecting electron density harmonics in piezoelectric semiconductors that are transparent to light. As intense sound waves pass through such a specimen, the permittivity is modulated due to modulation of the electron density. Light may be scattered by the ordinary plasma mechanism, or for greatest efficiency, Bragg scattering could be on a frequency close to the absorption edge. A tunable laser can be used as the light source. The three proposed mechanisms should be observable on semiconductors with a high piezoelectric constant such as CdS, CdSe, Te, GaAs, InSb, and also on surface acoustic waves in laminar piezoelectric-semiconductor structures. Figure 1, references 9: 7 Russian, 2 Western.
[31-6610]

ELECTRICITY AND MAGNETISM

UDC 621.384.83

USING HOMOGENEOUS MAGNETIC FIELDS FOR ELECTRON BEAM BUNCHING

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 9, Sep 81
(manuscript received 24 Dec 79, after revision 1 Oct 80) pp 1966-1968

AFANAS'YEV, V. D., VISHNYAKOV, V. A. and RUDYCHEV, V. G., Khar'kov State
University imeni A. M. Gor'kiy

[Abstract] An analysis is made of the bunching properties of systems consisting of a resonator with transverse magnetic or longitudinal electric field and a magnet with homogeneous field. It is shown that a buncher consisting of a resonator with transverse magnetic field and a deflecting magnet with uniform field is equivalent to a buncher of klystron type consisting of a resonator with longitudinal electric field and a drift section. Although the system with bunching in a magnetic field does not increase the energy spread in the shaped beam, the particles are scattered with respect to angles and the geometric dimensions of the beam increase due to spherical aberration. The phase characteristics of the system are the same as in the klystron buncher. The buncher with longitudinal electric field and deflecting magnet separates the trajectories of the particles in space depending on the time of entrance to the resonator, and is equivalent to a chopper. The bunching properties of this system improve with increasing initial particle energy. Thus the use of a deflecting magnet in place of a drift section gives a shaper equivalent to a system consisting of a chopper and a klystron buncher. References 7: 4 Russian, 3 Western.
[20-6610]

UDC 537.523.5

DYNAMIC CHARACTERISTICS OF ELECTRIC ARC IN ROTATING MAGNETIC FIELD AND PROBLEMS OF STABILITY OF ARC BURNING

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK: SERIYA TEKHNICHESKIKH NAUK in Russian No 8(338), Issue 2, Jun 81 (manuscript received 28 Jul 80) pp 109-117

YEGOROV, V. M., MOTOVILOV, V. V. and PUT'KO, V. F., Kuybyshev Polytechnical Institute

[Abstract] A dynamic model of an electric arc is constructed under conditions of action of a rotating magnetic field, and analytical criteria are derived for stability of arc burning modes in special cases of practical importance. The equations of motion of the arc are derived for the case where the time of transit of the rotating discharge through the chamber is insufficient for swirling of the gas to occur. Arc motion stability is analyzed with consideration of slipping of the electric discharge relative to the mass flow. An expression is found for the region of asymptotic stability of steady-state discharge motion in the rotating magnetic field. It is shown that an arc moving in a rotating magnetic field along a circular trajectory burns stably when the Kaufmann criterion is met, defined with respect to the static current-voltage curve of the moving arc. When the circular trajectory of the arc is fixed by wall or electrodes, the radius vector of the center of mass of the arc channel leads the magnetic field induction vector by an acute angle. Figures 2, references 12 Russian.
[23-6610]

UDC 537.525

EFFECT OF NORMAL CATHODE CURRENT DENSITY ON STABILITY OF SEMI-SELF-MAINTAINED GLOW DISCHARGE

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 19, No 4, Jul-Aug 81 (manuscript received 3 Nov 80) pp 881-883

BRONIN, S. Ya., GEMBARZHEVSKIY, G. V., KOLOBOV, V. M., SUSHKIN, V. M. and SHABASHOV, V. I., Institute of High Temperatures, USSR Academy of Sciences

[Abstract] Normal current density is experimentally determined in a semi-self-maintained glow discharge as the cathode surface is heated with simultaneous registration of limiting discharge parameters. The cathode was a massive copper cylinder heated by a nichrome heater. Cathode temperature was measured by a thermocouple. Experiments were done with nitrogen and air at cathode temperatures of 60 and 350°C. Analysis of the current-voltage characteristics shows that when the cathode is heated at pressures of 5-7 kPa, the voltage applied to the discharge drops by 70-100 V while the total current is maintained. This voltage

drop can be attributed to an increase in the initial cross section of the stream tube, leading to a reduction in resistance of the runoff zone. The energy input in the diffuse form of discharge as the cathode is heated or helium is blown into the cathode layer shows an increase that can be attributed to a reduction of normal current density. It is anticipated that further increasing the cathode temperature will intensify this effect. Figure 1, references 7 Russian.
[24-6610]

UDC 533.6.011.72

PROPAGATION OF SHOCK WAVES THROUGH WIDENING CHANNELS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 8, Aug 81 (manuscript received 26 Aug 80) pp 1735-1737

GOLOVIZNIN, V. P., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] An experimental and computer-aided numerical study was made of the propagation of shock waves through plane channels and through axisymmetrically widening channels. An experiment in the latter case is difficult to set up, while a numerical solution of the problem is just as easy in both cases. The calculations were made for a nonviscous and thermally nonconducting gas, according to the direct method using the McCormack difference scheme and monotonized by nonlinear conservative smoothing. The results of calculations are found to agree satisfactorily with the interferograms obtained for a flat nozzle and for an expanding nozzle, although interaction with the boundary layer could not be completely eliminated in the processing of experimental data. The author thanks A. I. Zhmakin, N. P. Mende and A. A. Fursenko for the helpful discussions, also I. M. Ponomareva for the assistance in formulating the study. Figures 3, references 3 Russian.
[17-2415]

UDC 533.601.312 and 533.601.314

AERODYNAMIC FORCES ON ROUGH ROTATING CYLINDER IN TRANSVERSE FLOW

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK: SERIYA TEKHNICHESKIKH NAUK in Russian No 8(338), Issue 2, Jun 81 (manuscript received 2 Oct 79) pp 32-39

BYCHKOV, N. M. and KOVALENKO, V. M., Institute of Theoretical and Applied Mechanics, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] An experimental study is done on aerodynamic forces on a rough cylinder in a crossflow in the T-324 low-turbulence wind tunnel at the Institute

of Theoretical and Applied Mechanics, Siberian Department, USSR Academy of Sciences. Airflow was varied from 10 to 60 m/s, degree of turbulence was 0.04 or 0.7%, and the rate of rotation of the cylinder ranged from 0 to 1600 rpm. Measurements were made on a smooth cylinder 150 mm in diameter, and on a rough version produced by cementing sandpaper to the surface with dimensions of the principal fraction being h = 100 μm, so that relative roughness was $h/d = 6.7 \cdot 10^{-4}$. Lift and drag were measured by strain gages with continuous oscillographic recording. It was found that the magnitude and behavior of aerodynamic forces of a rotating rough cylinder differ considerably from the case of a smooth cylinder due to peculiarities of flow in the wall region and the position of points of boundary layer separation. An increase in the degree of flow turbulence has no appreciable effect on aerodynamic forces of a rough cylinder in the transcritical region of Reynolds numbers. Figures 9, references 5: 3 Russian, 2 Western.
[23-6610]

UDC 532.516

MOTION OF VISCOUS FLUID ALONG TRAVELING WAVE AT HIGH SUBCRITICAL REYNOLDS NUMBERS

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK: SERIYA TEKHNICHESKIKH NAUK in Russian No 8(338), Issue 2, Jun 81
(manuscript received 12 Mar 80) pp 52-59

FERDIGALOV, L. Yu., Institute of Cybernetics, UkSSR Academy of Sciences, Kiev

[Abstract] It is shown that hydrodynamic drag reduction is possible in flow of a viscous liquid along on oscillating boundary when the oscillations are matched to a special type of flow that arises in the vicinity of the boundary at high subcritical Reynolds numbers. Flow of a viscous fluid is considered in an infinite flat channel bounded from above by a moving flat wall, and from below by a boundary that is impermeable to the fluid and that oscillates as a transverse traveling wave with time-invariant amplitude and shape. It is assumed that motion of the fluid in the channel with periodic boundary conditions is periodic and quasisteady. Analysis shows that active longitudinal-transverse oscillations of the boundary are required to maintain uniform eddy flow in the wall layer. Comparison of viscous flow over a flat plate and uniform eddy flow along a traveling wave shows that energy losses are considerably lower at high subcritical Reynolds numbers in the case of flow along a traveling wave. Figures 3, references 3 Russian.
[23-6610]

UDC 534.231.1

FREQUENCY CHARACTERISTICS OF NORMAL WAVES IN SHALLOW SEA WITH LAMINAR ABSORBING BOTTOM

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 27, No 5, Sep-Oct 81
(manuscript received 7 Jul 80) pp 669-677

AGEYEVA, N. S. and KRUPIN, V. D., Acoustics Institute imeni N. N. Andreyev,
USSR Academy of Sciences

[Abstract] An investigation is made of various frequency-response characteristics of the sound field of a point harmonic radiator in a shallow sea with laminar bottom by a computer method based on normal wave theory. This paper is a continuation of research started in a previous article [N. S. Ageyeva, V. D. Krupin, "Bottom Influence on Sound Field Formation in Shallow Sea", AKUSTICHESKIY ZHURNAL, Vol 26, No 2, 1980, pp 161-166] to explain the interference structure of experimentally observed sound fields in the sea. The sea is treated as a plane-parallel layer with speed of sound that varies with depth. The bottom is modeled by a homogeneous absorbing layer of liquid lying on a homogeneous liquid half-space. Based on this model, a computer program for characteristics of normal waves of a stratified sea with laminar absorbing bottom was used for numerical analysis of the frequency characteristics of modes: phase velocities, attenuation factors, depth distributions of amplitudes, and also horizontal and vertical profiles of the sound field over a wide frequency band. It is shown that despite incomplete information on the acoustic properties of the bottom, a numerical study of the behavior of mode characteristics in the frequency region can reveal some patterns that can serve as guidelines in analyzing the results of observations of the fine interference structure of the sound field in the actual sea, as well as finding practical application in the problem of mode identification. Figures 9, references 8: 7 Russian, 1 Western.
[30-6610]

LASERS AND MASERS

UDC 535.36:538.3

DYNAMIC COMPENSATION OF OPTICAL INHOMOGENEITIES IN IODINE LASER

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 8, Aug 81
(manuscript received 19 Sep 80) pp 1764-1765

DOLGOPOLOV, Yu. V., KORMER, S. B., KULIKOV, S. M., MURUGOV, V. M., PEVNYY, S. N., RYADOV, A. V. and SUKHAREV, S. A.

[Abstract] An experimental study was made to determine the feasibility of using inversion of the wave front for compensation of optical inhomogeneities in the active medium of lasers such as a C_3F_7I-laser used for thermonuclear fusion. A laser with an unstable telescopic resonator cavity served as the master laser for generating a reference radiation beam with a high degree of space coherence and a small divergence. During focusing of the radiation on a specimen of compressed (under 30 atm) SF_6, stimulated Mandel'shtam-Brillouin scattering with a Stokes frequency shift was made to occur under conditions designed to eliminate its effect on the master laser. The results demonstrate the effectiveness of dynamic compensation of optical inhomogeneities in iodine lasers by means of a Mandel'shtam-Brillouin mirror. Figures 2, references 11 Russian.
[17-2415]

UDC 621.378.325

EFFECT OF STIMULATED RAMAN SCATTERING ON EMISSION CHARACTERISTICS OF SOLID-STATE RING LASER

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 8, Aug 81
(manuscript received 15 Aug 80) pp 1741-1742

KORNIYENKO, L. S., KRAVTSOV, N. V. and NAUMKIN, N. I., Moscow State University imeni M. V. Lomonosov, Scientific Research Institute of Nuclear Physics

[Abstract] An experimental study was made to determine the feasibility of reducing the competitive interaction of opposing waves or compensating the

effect of asymmetric feedback in a solid-state ring laser by means of stimulated Raman scattering inside the resonator cavity. Into the focal region of the resonator cavity of a ruby pulse laser operating in the free-emission mode was inserted a telescopic system with a Raman active medium (benzene, or gaseous hydrogen under a pressure of 40 atm) inside an auxiliary resonator cavity coaxial with the main one. The results indicate that intracavity stimulation of Raman radiation is an effective method of compensation. Figure 1, references 2: 1 Russian, 1 Western.
[17-2415]

UDC 631.375

DETERMINING GAIN OF MOLECULAR LASERS FROM CHARACTERISTICS OF NONCOHERENT INFRARED RADIATION

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 8, Aug 81
(manuscript received 19 Jul 80) pp 1714-1716

KUDRYAVTSEV, N. N. and NOVIKOV, S. S., Institute of Chemical Physics,
USSR Academy of Sciences, Moscow

[Abstract] A method of determining the gain of CO_2-lasers is shown which utilizes the dependence of the radiation intensities in two vibrational-rotational bands 4.3 and 2.7 μm on two vibrational temperatures: upper-level 001 temperature $T_u = T_3$ characterizing the distribution within the asymmetric mode, lower-level 100 temperature $T_1 = T_2$ characterizing the distribution within the symmetric mode and the deformation mode. With sufficient experimental data, the corresponding system of two integrals can be evaluated numerically by the Newton method on a high-speed computer. The calculated temperatures yield the gain according to a well known relation between them. The method was tested on a gas-dynamic ($0.100_2 + 0.4N_2 + 0.5He$) pulse laser and checked against the conventional probing transillumination method, the agreement of results having been found to be quite satisfactory. Figure 1, table 1, references 4 Russian.
[17-2415]

UDC 538.561

EMISSION OF COHERENT RADIATION BY BEAM OF RELATIVISTIC ELECTRONS IN UNDULATOR

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 8, Aug 81
(manuscript received 9 Jul 80) pp 1633-1642

KONDRATENKO, A. M. and SAL'DIN, Ye. L., Institute of Nuclear Physics,
Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] Emission of coherent radiation by an electron beam moving through a helical undulator, in a laser device without a resonator cavity, is analyzed on

the basis of the results of an earlier study and new approaches. First is considered self-modulation of narrow and wide relativistic beams in the single-transit mode, with constraints on the energy spread and the angular spread of particles as well as on the gradient of longitudinal velocity in the undulator entrance section, these constraints determining the maximum attainable current and radiation energy. Next is considered independent control of the "mass of longitudinal motion" (relating the change in longitudinal velocity to the change in energy, and of the amplitude of the transverse velocity by means of a sufficiently strong extra magnetic field in the undulator. The principle of controlled self-modulation is applicable to the design of a source of coherent submillimeter-wave radiation, a practical powerful source of such radiation not yet being available. Theoretical calculations based on typical numerical data indicate the feasibility of generating an average radiation power of 15 kW with a 200 kW electron source and with 30 cm long bunches appearing at a repetition rate of 10^6 s^{-1}, the controlling magnetic field being 28 kG strong. The authors thank Ya. S. Derbenev for the helpful stimulating discussions and A. N. Skrinskiy for the interest in this study. References 7: 3 Russian, 4 Western.
[17-2415]

UDC 621.373:535

USING MAGNETIC FIELD TO CONTROL POSITION AND WIDTH OF UNIDIRECTIONAL EMISSION REGION IN RING GAS LASER

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 3, Sep 81
(manuscript received 2 Apr 81) pp 385-388

KOS'MINA, M. A., STROKOVSKIY, G. A., TOLCHINSKAYA, T. B., TIUNOV, Ye. A. and FRADKIN, E. Ye.

[Abstract] Previous research on competition of opposed waves in ring lasers on a pure isotope has shown symmetric narrowing of the region of unidirectional emission to zero with an increase in the magnetic field intensity on the active medium regardless of sign. This paper describes an experiment in which a new effect is observed: expansion of the region of unidirectional emission as the magnetic field is increased to cover the entire region of single-mode lasing. The studies were done on a three-mirror ring gas laser on the 0.63 μm line. The cell with active medium had Brewster windows and was placed inside a solenoid. Inhomogeneity of the magnetic field along the axis of the optical cavity did not exceed 0.06%/mm, and along the diameter was no more than 0.02%/mm. The active medium was formed by isotopes ^{3}He and ^{20}Ne (enrichment 99.85%) in a ratio of 6:1 at a total pressure of 2.4 mm Hg. The cavity also contained a Faraday nonreciprocal device and a loss calibrator. These components were adjusted by varying the polarization parameters of the optical cavity. Lasing intensity in both directions was measured as a function of the detuning of the emission frequency from the center of the amplification line. The discrepancy with the results of

previous research is explained as follows. When a magnetic field is applied to the cell with active medium, the working levels of the gas atoms are split, resulting in three effects: 1. splitting of the amplification line and separation of the Bennett gaps (linear and nonlinear effect); 2. loss of coherence of magnetic sublevels; 3. Faraday rotation of the plane of polarization. It is suggested that the use of a magnetic field to control the position and width of the region of strong competition could be a basis for new capabilities in nonlinear laser spectroscopy using ring gas lasers. Figures 2, references 4 Russian.
[21-6610]

UDC 621.373:535.01

EMISSION FREQUENCY SPLITTING IN RING LASER WITH RECTANGULAR DIAPHRAGM, PART IV

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 3, Sep 81
(manuscript received 17 Apr 80) pp 493-500

GLUSHCHENKO, Yu. V., RADINA, T. V. and FRADKIN, E. Ye.

[Abstract] A practical expression is derived for calculating the diffraction independence of frequencies of opposed waves in a single-mode ring laser with rectangular diaphragm. It is shown that there is a considerable difference between this expression and the frequency-difference formula derived by the method of perturbation theory. The results of numerical calculations are analyzed and compared with data in the literature. The derivation based on Slater's approach compares favorably with results of numerical integration of Fox and Lee equations with subsequent reconstruction of the field in the cavity using the Kirchhoff integral. Better agreement is observed with lessening diffraction. Thus, Slater's method is applicable to calculation of diffraction frequency splitting in the region of weak diffraction where calculations by numerical methods are difficult. It is found that cavities with degenerate frequency spectrum and minimum diffraction losses of the fundamental mode are characterized by minimum diffraction splitting of frequences. Figures 6, references 16: 15 Russian, 1 Western.
[21-6610]

UDC 621.373:535

SPATIAL FILTRATION OF APODIZED LASER BEAMS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 3, Sep 81
(manuscript received 2 Apr 80) pp 509-514

KUZ'MINA, N. V., ROZANOV, N. N. and SMIRNOV, V. A.

[Abstract] Small-scale self-focusing in laser facilities is suppressed by a spatial filter made up of two lenses with a diaphragm in their common focal plane to cut off emission perturbations arising in components of the amplification system preceding the filter. In systems with considerable nonlinearity, large-scale "external" self-focusing also becomes important, causing shielding of part of the main beam on the filter diaphragm. The resultant distortions increase with a reduction in the diameter of the diaphragm, complicating the job of selecting filter parameters. While the influence of "external" self-focusing can be analyzed in the "aberrationless" approximation, such calculations lose force near the focal plane. In this paper a numerical and analytical study is done on the passage of laser beams with different degrees of apodization through an amplification stage containing a spatial filter. An approximate analytical expression is found for the field amplitude on the sides of the beam with arbitrary degrees of apodization. An analysis is made of the influence of apodization on distortions introduced by the diaphragm, and the development of these distortions in following nonlinear components. It is shown that the capabilities of spatial filtration of apodized laser beams are appreciably dependent on the shape of the beam and the integral of decay of the system. Figures 6, references 13: 9 Russian, 4 Western.
[21-6610]

UDC 621.378.325

REFINEMENT OF VIBRATIONAL TEMPERATURE MODEL FOR DESCRIBING EMISSION CHARACTERISTICS OF SHORT-PULSE CO_2-N_2-He LASER

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 9, Sep 81
(manuscript received 22 Jul 80, after revision 4 May 81) pp 1876-1884

PIVOVAR, V. A.

[Abstract] The vibrational-temperature approximation is improved for CO_2-N_2-He lasers with emission pulse duration of the order of one microsecond or less at high pumping levels $Q/P = 0.5$-$1.0\ J/cm^3\cdot atm$ by including effects of non-Boltzmannian population of vibrational levels of nitrogen in times of the order of one microsecond or less, and the influence of anharmonicity in CO_2 and N_2 oscillators at high pumping levels. Consideration of these effects gives a more exact description of the emission process in the initial period. Kinetic equations including v-v and v-t exchange in the anharmonic approximation are used

to calculate the kinetics of population of vibrational levels of N_2 oscillators and the antisymmetric type of vibration of CO_2. It is shown that inconsistencies of the vibrational temperature model with respect to time of lasing onset and the amplitude of the first lasing spike can be explained by accounting for non-Boltzmannian population of the first eight electron-excited vibrational levels and anharmonicity of exchange in oscillators of mode ν_3 in CO_2 and ν_4 in N_2 at short times and high pumping levels. The proposed model that describes pumping processes on the basis of the exact electron distribution function calculated from Boltzmann's kinetic equation for electrons and characterizes processes of vibrational exchange with consideration of anharmonicity in the above-mentioned oscillators improves agreement with observed lasing behavior: within 20-30% for the amplitude of the first lasing spike, and within 10-15% for the time of lasing onset. Figures 7, references 20: 12 Russian, 8 Western.
[20-6610]

UDC 535:621.375.826

INFLUENCE OF OXYGEN ON NITROGEN LASER EMISSION

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 19, No 4, Jul-Aug 81 (manuscript received 18 Nov 80) pp 873-875

ASINOVSKIY, E. I., VASILYAK, L. M. and TOKUNOV, Yu. M., Institute of High Temperatures, USSR Academy of Sciences

[Abstract] An investigation is made of the effect that oxygen additives have on stimulated emission at $\lambda = 337.1$ nm in a coaxial nitrogen laser. The gas was excited by negative voltage pulses of 9 ns duration with amplitude of 250 kV, rise and fall times of 2.5 ns. Laser emission was analyzed by an MDR-2 monochromator and HSD 1850 photocell with rise time of 0.1 ns, and S7-10B and S7-15 oscilloscopes (passbands of 1 and 5 GHz respectively). A reduction in peak power and energy of an open-air laser with $\lambda = 337.1$ nm is observed as compared with a pure nitrogen laser. This is attributed to quenching of the upper lasing level by oxygen molecules with quenching cross sectionoof $(52 \pm 11) \cdot 10^{-16}$ cm^2. Figures 2, references 9: 5 Russian, 4 Western.
[24-6610]

UDC 621.375.826

CHARACTERISTICS OF CARBON MONOXIDE GAS-DISCHARGE OVERTONE-LASER: I. STEADY STATE

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 41, No 2, Aug 81
(manuscript received 10 Jun 80) pp 289-294

KONEV, Yu. B., KOCHETOV, I. V., KURNOSOV, A. K., PEVGOV, V. G. and
DEM'YANOV, A. V., Institute of High Temperatures, USSR Academy of Sciences,
Moscow

[Abstract] CO overtone-lasers with high efficiency in the near infrared range of the spectrum are used for various processes in the chemical industry such as separation of isotopes. An earlier study of the populations of vibrational states has indicated the feasibility of a partial inversion at J—1, v → J, v—k transitions not only when $k = 1$ but also when $k \geq 2$, with the theoretical gain on the first overtone exceeding $0.1\ m^{-1}$ under experimental conditions. In this study a numerical solution of the system of kinetic equations for the populations of levels, including the Boltzmann equation, yields the distribution of CO molecules over vibrational levels and the spectrum of emission on vibrational-rotational transitions. The first overtone is of practical interest, the beginning of its spectrum shifting from $v = 12$-14 level at a low temperature (80 K) to $v = 20$-22 levels at higher temperatures (140-180 K) and its peak shifting correspondingly to $v = 24$-26 levels. The spectrum of the first overtone is also rather wide, owing to the proximity to the threshold, its long-wave edge corresponding to $v = 30$-32 levels at all these temperatures. The efficiency of emission has been calculated as a function of the temperature and, at the higher temperatures, as a function of the pumping power. The problem of selective emission is also considered, the efficiency depending on the vibrational transition for the first overtone at which a given line of the spectrum corresponding to the maximum gain with respect to the rotational quantum number is extracted. An efficiency of 28% seems to be attainable at $W = 1\ W/cm^3$ and $T = 150$ K with $G = 5 \cdot 10^{-4}\ cm^{-1}$ when $n_{CO} = 1.8 \cdot 10^{17}\ cm^{-3}$ and $n_{He} = 1.8 \cdot 10^{18}\ cm^{-3}$. Figures 4, references 8 Russian.
[213-2415]

UDC 536.621.373

THERMAL CONDITIONS OF THE LIGHT GENERATING SYSTEM OPTICAL ELEMENTS IN SOLID-STATE LASER WITH NATURAL COOLING

Minsk INZHENERNO-FIZICHESKIY ZHURNAL in Russian Vol 41, No 2, Aug 81
(manuscript received 13 May 80) pp 295-301

DUL'NEV, G. N. and KHANKOV, S. I., Leningrad Institute of Precision Mechanics
and Optics

[Abstract] The temperature distribution in the active cell is the most important factor affecting the design and the performance of a solid-state laser. Here

a practical approximate analytical solution to the problem of determining it is shown, an exact solution being quite cumbersome and requiring the aid of a computer. The light generating optical system of a solid-state laser consists essentially of three elements: two parallel cylinders with heat sources (lamp and active cell) inside a heat emanating cylindrical shell (luminaire). Calculation of their temperatures reduces to integration of a system of three first-order linear ordinary differential equations, if the cylinders are assumed to have a large length-to-diameter ratio, that heat emanation occurs at their lateral surface only and quasi-continuously under conditions of natural cooling while the laser operates in the periodic-pulse mode, and that the heat transfer coefficients as well as the thermo-physical/properties of the materials do not depend on the temperature. This system of equations is solved under two additional assumptions, namely that the luminaire heats up much slower than the lamp and the active cell, and that the thermal flux from the lamp to the active cell is much smaller than that from the lamp to the luminaire. On this basis, for typical length-to-diameter ratios $L/D \geq 10$, the excess temperatures of the three elements are calculated as functions of the average pumping power up to 1000 W in the steady-state mode and as functions of the laser operating time at an average pumping power of 25 W during the transient period, for a YAG:Nd^{3+} laser and an ISP 600 flash lamp. Also calculated are the thermal conductances (W/K) between the three elements and from the luminaire to the ambient medium, as functions of the average pumping power in the steady-state mode. The results are compared with experimental data. Figures 3, references 11 Russian.
[213-2415]

MOLECULAR PHYSICS

UDC 533.6.011:537.533

ELECTRON-BEAM DIAGNOSIS IN NITROGEN: SECONDARY PROCESSES

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 9, Sep 81 (manuscript received 2 Jul 80, after revision 15 Jan 81) pp 1832-1840

REBROV, A. K., SUKHININ, G. I., SHARAFUTDINOV, R. G., LENGRAND, J. C., Institute of Thermal Physics, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] Existing models that relate intensities of emission stimulated by an electron beam in a gas to the density of the gas, and to the population of vibrational and rotational levels of molecules, are not adequate for accurate interpretation in electron-beam diagnosis. Based on careful experimental studies and analysis of the literature, the authors investigate excitation of state $B^2\Sigma_u^+$ of the nitrogen ion as the probing electron beam interacts with the gas. A kinetic model is proposed for determining the distribution of secondary electrons, their contribution to stimulation of the first negative system of nitrogen bands, and also their influence on measurements of gas density and populations of rotational levels. It is shown that ionization of nitrogen to state $N_2^+B^2\Sigma_u^+$ occurs with more change in the rotational quantum number for impact by secondary electrons than for ionization by fast primary electrons. The linear Boltzmann's integral equation is used in determining the secondary electron distribution function. It is found that secondary electrons can introduce a considerable error in determination of the populations of upper rotational levels. This error can be reduced by doing measurements through a narrow monochromator slit parallel to the beam to minimize halation of the spectral recording. The contribution of secondary electrons to the observed spectra increases for more equilibrium population distributions. Figures 5, references 19: 4 Russian, 15 Western.
[20-6610]

UDC 537.5

INVESTIGATION OF 'FAST' HEATING OF OXYGEN IN NON-SELF-MAINTAINED DISCHARGE

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 19, No 4, Jul-Aug 81
(manuscript received 14 Apr 80) pp 720-728

LONDER, Ya. I., MENAKHIN, L. P. and UL'YANOV, K. N., All-Union Electrical
Engineering Institute imeni V. I. Lenin

[Abstract] An experimental study is done on the energy balance of electrons in oxygen in a non-self-maintained pulse discharge at E/N = $(8-30)\cdot10^{-17}$ V$\cdot$cm^2. The experimental data are analyzed and compared with theory [see R. Sh. Islamov, I. V. Kochetov, V. G. Pevgov, "Analiz protsessov vzaimodeystviya electronov s molekuloy kisloroda" (Analysis of Processes of Interaction of Electrons With an Oxygen Molecule), Preprint FIAN (Lebedev Physics Institute), Moscow, 1977, No 169]. Relaxation of energy invested in an oxygen discharge takes place through two channels with very different characteristic times. Heating of a heavy particle gas in oxygen via the channel with characteristic relaxation time much less than the pulse time is called "fast" heating. The experimental method used to measure fast heating in oxygen is based on determining the heating of gas by the pressure rise in a closed discharge chamber with homogeneous pulse discharge. A strain-gage sensor was used to measure pressure. The technique enabled reliable measurement of a pressure change of about 1 kPa per pulse with time resolution of about 50 μs. The measurements were done in oxygen with impurity content (mostly N_2) of no more than 0.8% at pressures of 12.6, 25.3 and 101 kPa and initial temperature of about 20°C. The gas was ionized by an electron beam coupled in through aluminum foil. The relative fraction of ion current as a function of E/N is determined from equations of balance of charged particles. It is shown that it is important to account for the chemical reaction of ozone formation in energy balance of electrons in oxygen. When this reaction is considered, satisfactory agreement is observed between experiment and theory. A possible reason for increased discharge current during a pulse may be increasing electron concentration due to an increase in the rate of unsticking as negative ions collide with metastable molecules of $O_2(a^1\Delta_g)$. Figures 6, references 23: 15 Russian, 8 Western.

[24-6610]

UDC 621.384.6

ACCELERATION OF ELECTRON BEAM IN ARRAY OF RADIAL LINES EXCITED BY EXTERNAL PULSE GENERATOR

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 8, Aug 81
(manuscript received 19 Aug 80) pp 1750-1752

ZAKUTIN, V. V. and SHENDEROVICH, A. M.

[Abstract] An electron beam was successfully accelerated in an array of twin radial lines, upon excitation of the latter by an external pulse generator. The array included accelerating lines, outside radius $R = 9$ cm and inside radius $r = 3$ cm, filled with 60NN ferrite. It also included shorting lines around the ferrite rings. The accelerating lines were excited through 12 coaxial cables by a voltage pulse with a 1-8 ns rise time. The accelerating voltage was measured as a function of the ratio of electron transit time to pulse rise time and as a function of the electron beam current. The results agree closely with calculations. Figures 2, references 7: 4 Russian, 3 Western.
[17-2415]

UDC 537.533

INTENSE PULSED ELECTRON BEAM GENERATION IN MODERATE-DENSITY GAS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 9, Sep 81
(manuscript received 2 Jul 80, after revision 2 Sep 80) pp 1823-1831

BOKHAN, P. A. and KOLBYCHEV, G. V., Institute of Optics of the Atmosphere, Siberian Department, USSR Academy of Sciences, Tomsk Affiliate

[Abstract] Existing electron guns are incapable of shaping electron beams when the gas density in the accelerating region exceeds about 10^{15} cm^{-3}. The authors discuss a new technique for beam shaping in denser gas by using the effect of escaping electrons in a dense-gas discharge. Experiments are done to determine the type of discharge in which escaping electrons are most efficiently generated at a gas pressure of more than 100 Pa, and an estimate is made of the maximum

generation capacity of such a discharge. The experimental facility was a hermetically sealed quartz discharge chamber containing plane-parallel electrodes: an interchangeable cathode and a grid-type anode with geometric transparency of about 80%. Opposite the cathode and behind the anode was a movable collector grounded like the anode through a low-inductance ohmic current-measuring shunt. The discharge chamber was filled with gas to the required pressure. The chamber was sheathed on the outside with a grounded copper bus having windows for observing the discharge, which was excited by a capacitor charged to 4-10 kV connected to the chamber electrodes through a TGI1-1000/25 thyratron. Signals from the current-measuring shunts in the anode and collector circuit, and from an ohmic voltage divider on the cathode were recorded by a stroboscopic oscilloscope and a chart recorder. A strongly inhomogeneous field was produced by using cathodes consisting of coaxial molybdenum foil cylinders with the ends facing the anode and filled flush with epoxy resin. Massive cathodes made of brass, duralumin, stainless steel or LaB_6 were used. The best emission properties were observed in a weak-current volumetric discharge of nanosecond duration, in which practical transfer of the charge accumulated in the discharge capacitor to the electron-beam charge may reach 60-80%. The proposed technique produced an electron beam with energy of 2-3 keV, current density of 10-80 A/cm^2, pulse duration of 25-130 ns at a practical efficiency of 30-50% and recurrence rates up to 1 kHz. This method of producing high-intensity pulsed electron beams should be applicable to stimulation of emission in gas lasers. Figures 6, references 14: 13 Russian, 1 Western.
[20-6610]

UDC 538.561

SPONTANEOUS SHORTWAVE EMISSION BY INTENSE ELECTRON BEAM

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 9, Sep 81
(manuscript received 5 Sep 80) pp 1870-1875

LEBEDEV, A. N. and MARTIROSYAN, G. V., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] An investigation is made of spontaneous lengthwise intense magnetobremsstrahlung of high-current relativistic electron beams with a strong magnetic motion of an individual particle under the action of collective fields is ordered and periodic, and therefore the interference of radiation from different sections of the trajectory leads to narrow-band emission for a wave vector directed along the beam. A high-resolution spectral line of spontaneous radiation that depends on particle energy would indicate the possibility of a laser mechanism of amplification (or stimulated emission) without using external fields. The authors calculate the angular and spectral distribution of spontaneous undulator radiation of a relativistic electron beam with self-field for a specific model in which the particle velocity and emission are directed sharply forward. Effects of induced emission are disregarded, and it is assumed that the radiation frequency is much higher than the Langmuir frequency of the beam electrons so that collective

vibrational properties can be disregarded, and the beam can be considered transparent, i.e. the wavelength is taken as much shorter than the depth of the collisionless skin layer. It is shown that radiation is considerably dependent on beam current: with increasing current the directionality of the radiation deteriorates, total power increases, and the spectrum becomes broader. Figures 3, references 6: 3 Russian, 3 Western.
[20-6610]

UDC 537.533

FILAMENTARY STRUCTURE OF TUBULAR RELATIVISTIC ELECTRON BEAM

Moscow FIZIKA PLAZMY in Russian Vol 7, No 4, Jul-Aug 81
(manuscript received 28 Aug 80) pp 784-789

IVANOV, V. S., KREMENTSOV, S. I., RAYZER, M. D., RUKHADZE, A. A. and
FEDOTOV, A. V., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Previous research has revealed azimuthal perturbations of an intense relativistic electron beam as it is transported through a cylindrical waveguide either without beam neutralization or with partial neutralization of the charge by ionization from a neutral gas beam. An analogous effect has been observed when a cylindrical electron beam propagates in a cylindrical waveguide with variable cross section, where the azimuthal perturbations strongly distort the beam structure at considerable distances from the point of injection, the hollow beam being replaced by a continuous structure at a certain distance from the injection point. This paper describes experiments on studying the beam structure with transport in a regular cylindrical waveguide as a function of the length of transport and longitudinal magnetic field intensity. The injector was a Terek-1 accelerator in which the electron flux was produced by a coaxial diode with magnetic insulation. Maximum electron energy was 670 keV, beam current 5 kA, pulse duration 20 ns, residual pressure in the waveguide $5 \cdot 10^{-6}$ mm Hg. Beam macrostructure was studied by self-prints on celluloid plates 0.5 mm thick. It was found that an initially uniform tubular electron beam in the drift space at a certain distance from the plane of injection is broken up into separate jets and takes on an azimuthally inhomogeneous structure. The observed effects are interpreted as development of diocotron instability in a tubular electron beam at finite external longitudinal magnetic field intensities. It is concluded that the diocotron effect must be taken into consideration when designing electromagnetic readiation oscillators based on intense electron beams. Figures 5, references 8: 6 Russian, 2 Western.
[19-6610]

UDC 533.951.8

TRAPPED ALPHA-PARTICLE MAGNETOACOUSTIC INSTABILITY IN TOKAMAK WITH ELLIPTICAL CROSS SECTION

Moscow FIZIKA PLAZMY in Russian Vol 7, No 4, Jul-Aug 81
(manuscript received 23 May 80, after revision 18 Oct 80) pp 820-827

KALADZE, T. D., Institute of Applied Mathematics, Tbilisi State University

[Abstract] Previous research has shown cyclotron excitation of fast magnetoacoustic waves by trapped alpha-particles formed during nuclear fusion in a tokamak with elliptical cross section. However, previous analysis has ignored longitudinal oscillations of the trapped particles between the magnetic mirrors of the torus, which should be taken into consideration under tokamak reactor conditions. In this paper, refinements are introduced into expressions for increments by accounting for bounce resonances that arise during longitudinal oscillations of trapped particles. General expressions are derived for the increments of buildup of oscillations in cases of weak and strong ellipticity. Analysis of excitation of waves with frequencies close to cyclotron harmonics of strongly trapped alpha-particles shows that bounce resonances may cause additional intensification of the increment of excitation of fast magnetoacoustic waves. Figures 2, references 5: 2 Russian, 3 Western.
[19-6610]

UDC 533.951.8

BRILLOUIN ELECTRON FLOW INSTABILITY

Moscow FIZIKA PLAZMY in Russian Vol 7, No 4, Jul-Aug 81
(manuscript received 30 Jun 80, after revision 3 Nov 80) pp 930-937

GORDEYEV, A. V., GULIN, A. V. and SAVENKOVA, N. P., Institute of Applied Mathematics imeni M. V. Keldysh

[Abstract] An investigation is made of stability of steady-state Brillouin electron flow with respect to small perturbations that are independent of coordinate lengthwise of the flow velocity. The analysis is distinguished from previous research by the aperiodic nature of development of perturbations as a result of uniformity of perturbations along the direction of flow. It is shown that Brillouin flow of electrons in a cylindrical coaxial vacuum line is unstable with respect to troughs formed on the surface of the electron layer and extending in the direction of the z-axis. The increment of this instability is of the order of 10^9 s^{-1}. Figures 2, references 19: 12 Russian, 7 Western.
[19-6610]

UDC 533.951.8

NONLINEAR ENERGY PRINCIPLE AND KINK INSTABILITY OF COMPACT TORUS

Moscow FIZIKA PLAZMY in Russian Vol 7, No 4, Jul-Aug 81
(manuscript received 29 Aug 80) pp 938-942

DREYZIN, Yu. A. and SOKOLOV, Ye. P., Moscow Physicotechnical Institute

[Abstract] MHD stability of a compact torus configuration is studied by using a nonlinear variational principle. The unstable mode is found for the entire class of configurations in which the plasmoid is enclosed in a long cylindrical chamber, and one of the possible versions of development of this instability is studied under nonlinear conditions. An analysis is made of two possible methods of stabilizing such an instability by magnetic mirrors and an azimuthal magnetic field. It is shown that a long plasmoid can be made stable by a relatively weak toroidal magnetic field. It is pointed out that the MHD approximation used in this work must be refined for more complete analysis of the stabilization problem with consideration of the finiteness of the Larmor radius of ions and other kinetic effects. Figures 2, references 9: 4 Russian, 5 Western.
[19-6610]

UDC 517.958

OPTIMIZING SYSTEMS FOR AFTER-ACCELERATION OF INTENSE CHARGED PARTICLE FLUXES

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 21, No 5, Sep-Oct 81 (manuscript received 6 Jan 81) pp 1333-1338

KULYGIN, V. M., SVESHNIKOV, A. G., SEMASHKO, N. N. and YAKUNIN, S. A., Moscow

[Abstract] In some design problems, such as negative-ion injectors for controlled fusion reactors and ion engines for spacecraft, it is necessary to provide additional acceleration of streams of particles pre-shaped into an intense beam. In this situation, the parameters of the after-acceleration system such as geometric dimensions and distribution of potentials on the electrodes must be selected from compromise considerations. On the one hand, the secondary particles should pick up minimum energy on the path from the point of production to the wall to avoid destruction, and on the other hand, the divergence of the ion beam and deviation from the axis of the system must be minimized. The authors consider this optimization problem and propose an algorithm for solution that is applicable to the design of after-acceleration systems. The parameters of the criterion functional are the geometric dimensions of the region and the distribution of electric potential at the boundary. The solution minimizes the angle of divergence at the output and the energy losses on acceleration of secondary-ionization particles and electrons. The efficacy of the proposed technique is demonstrated by a specific example. Figures 2, references 10 Russian.
[37-6610]

OPTICS AND SPECTROSCOPY

UDC 535.317.1

STATIC AND DYNAMIC THREE-DIMENSIONAL HOLOGRAMS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 8, Aug 81
(manuscript received 23 Jun 80) pp 1648-1655

DENISYUK, Yu. N.

[Abstract] The modal theory of three-dimensional holograms, proposed in 1976 by the Soviet physicist V. G. Sidorovich, is here applied to an analysis of the image producing characteristics of brightness waves and their dependence on the properties of the light-sensitive medium. On a volume of such a medium is assumed to impinge a complex wave consisting of superposed plane waves which, as a result of interference, produce an intricate brightness pattern. The hologram is recorded in a medium with a phase response. The interaction of the medium with light, including the generation of acoustic waves and a phonon echo, is interpreted in terms of this theory. Owing to this interaction, dynamic holograms recorded in resonant scattering media make it possible to invert wave fronts and to record not only space characteristics but also time characteristics of wave fronts. Static holograms feature a high diffraction efficiency and make it possible, with a sensitized reaction of the photo-oxide, to modulate the refractive index in the visible range through absorption of near-ultraviolet radiation. Figures 4, references 26: 17 Russian, 9 Western.
[17-2415]

UDC 535.33

SUPERLUMINESCENCE SPECTRAL BEHAVIOR

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 3, Sep 81
(manuscript received 21 Apr 80) pp 406-410

MALIKOV, R. F., MALYSHEV, V. A. and TRIFONOV, Ye. D.

[Abstract] An analysis is made of the way that pulse shape and spectral behavior depend on homogeneous and inhomogeneous broadening in collective

spontaneous emission of a polyatomic inverted system under conditions where relaxation of the nondiagonal elements of the density matrix and the associated dipole moments of atoms occurs more slowly than the de-excitation process. A distinguishing feature of this superluminescence effect is square-law dependence of intensity on inversion density. The analysis is based on a system of contracted equations of semiclassical superluminescence theory, describing the behavior of slowly changing amplitudes of waves of the electric field and polarization of the electronic subsystem propagating in one direction. Solution of this system of equations gives the pulse shape of cooperative spontaneous radiation and the Fourier spectrum of emission at different values of the homogeneous and inhomogeneous times of transverse relaxation. It is shown that the superluminescence spectrum is symmetric relative to the transition frequency in an isolated atom. As phase relaxation increases, the number of peaks in the emission pulse and in its spectrum decreases. Calculation shows that Stark splitting correlates with splitting of the corresponding doublets in the emission spectrum. It is shown that the observed spectral shape is due to optical nutation in the proper field of superluminescent emission. Since spectral shape is found to be weakly dependent on pulse delay time, the observed structure can be taken as an indicator of superluminescence, especially in cases where the oscillatory structure of the de-excitation pulse is unresolved due to superposition of pulses with different delay times. Figures 3, references 12: 5 Russian, 7 Western.
[21-6610]

UDC 535.87:621.373:535

LASER MIRRORS FOR FAR XUV

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 3, Sep 81
(manuscript received 10 May 79, after revision 24 Feb 81) pp 515-519

BOGACHEV, M. B., KOLTYGIN, V. M., PLOTKIN, M. Ye., RAGOZIN, Ye. N. and SUKHODREV, N. K.

[Abstract] Optical cavities for the extreme ultraviolet require mirrors that reflect effectively in the shortwave region with normal incidence. The best reflectors in the region of wavelengths shorter than 1000 Å are refractory metals. The authors study mirrors for the XUV region made from massive polycrystal specimens of molybdenum, tungsten and rhenium produced by double remelting in vacuum. The reflectivity was measured by a VMR-2 vacuum monochromator with a helium discharge in a capillary as the source of radiation and a photomultiplier equipped with a converter to shift UV radiation into the visible band. Angle of incidence was 12°. An investigation was also made of the surface roughness of glass, steel and tungsten by the method of interference bands of equal chromatic order. After polishing and before measurements, the surfaces were cleaned with organic solvents. It was found that hexane is best for this purpose. The coefficients of reflection were measured for incident wavelengths from 537 to 1200 Å after prolonged exposure to air. Rhenium showed the highest reflectivity of 34% at 584 Å, while molybdenum had the lowest reflectivity of 9% at 537 Å. It was found that polished glass can be used as a backing for a mirror with specular reflection down to wavelengths of the order of 100 Å, while polished metal mirrors are capable of specular reflection only down to about 500 Å at normal incidence. Unexpectedly, isolated large roughnesses with dimensions of the order of 500 Å x 200 μm could be distinguished by eye in visual inspection of the surface. Figures 3, references 5: 2 Russian, 3 Russian.

UDC 621.378.325

OPTICAL BISTABILITY AND HYSTERESIS IN FOUR-BEAM WAVEFRONT REVERSAL IN FERROELECTRICS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 9, Sep 81
(manuscript received 16 Sep 80) pp 1990-1993

KUKHTAREV, N. V. and SEMENETS, T. I., Institute of Physics, UkSSR Academy of Sciences, Kiev

[Abstract] Theoretical studies of the four-beam wavefront reversal technique have demonstrated that bistable states show up in liquids for light beam intensities of about 10^4 W/cm^2. This effect could be used to develop new non-resonator optical devices such as optical transistors and memory units. In this paper it is proposed that optical bistability should be possible with wavefront reversal in ferroelectrics where the effect takes place at low intensities of the order of 0.1 W/cm^2, enabling the use of cw lasers in systems with bistable components. An analysis is made of equations for holographic wavefront reversal at high efficiencies, where new effects may show up in the system, and conditions are found for experimental realization. It is shown that in the case of high wavefront reversal efficiencees in ferroelectrics, optical bistability and hysteresis may arise due to discontinuities of the isophase surfaces of the holographic gratings. These effects may be realized in $LiNbO_3$ and $LiTaO_3$ at intensities of the order of 0.1 W/cm^2. The parameters of bistability can be controlled by an external electric field of about 30 kV/cm. References 10: 5 Russian, 5 Western.
[20-6610]

SUPPRESSING EFFECT OF SMALL-SCALE SELF-FOCUSING WITH BEAM ROTATION, JITTER OR WOBBLE

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 9, Sep 81
(manuscript received 24 Sep 80, after revision 13 Jun 81) pp 1996-1999

ASKAR'YAN, G. A. and MUKHAMADZHANOV, M. A., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Self-stress of intense beams in a medium as a result of arisal of a nonlinear waveguide causes rapid growth of small-scale inhomogeneities of beam intensity distribution leading to breakdown of optical and active media, nonlinear scattering and absorption, and preventing collapse of the beam as a whole. The authors consider new possibilities for eliminating these small-scale effects and their consequences by small beam movements that do not noticeably change beam dimensions: rotation, wobbling, flicker and jitter. An analysis is made of inertial nonlinearities where the risetime of nonlinear refraction is large compared with the period of beam rotation or wobble, so that intensity averaging becomes important for the dynamics of nonlinear refraction, and fast nonlinearities that must be suppressed to avoid beam collapse. Beam motion was produced by a rotating Dove prism or an electrooptical deflector system. Experiments show the feasibility of controlling small-scale processes of nonlinear refractions by slight beam movements. In particular, beam rotation can eliminate small-scale processes while allowing axial collapse of the beam, which is important for producing high concentrations of energy. Figures 5, references 10: 6 Russian, 4 Western.
[20-6610]

UDC 536.21:65.011.56

FAST-ACTION AUTOMATED SYSTEM FOR HIGH-TEMPERATURE MEASUREMENTS (2500-6000 K) WITH HEATING BY LASER EMISSION

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 19, No 4, Jul-Aug 81
(manuscript received 12 Dec 80) pp 839-848

SHEYNDLIN, M. A., KIRILLIN, A. V., KHEYFETS, L. M. and KHODAKOV, K. A., Institute of High Temperatures, USSR Academy of Sciences

[Abstract] Considerable experimental data have now been accumulated on the thermophysical properties of carbon at high pressures and temperatures. Nonetheless, certain key problems remain unsolved relating to the phase diagram of carbon. Of particular interest among these problems is the temperature level at the solid-liquid-vapor triple point. In this connection the authors describe a system of measuring the temperature of specimens heated by high-intensity steady-state laser radiation in a chamber under high inert gas pressure. The system includes a monochromatic pyrometer, a fast-acting spectral ratio micropyrometer with large linear dynamic range (10^5), equipment for

high-speed registration of emission spectra, and a system for controlling the experiment and computer-processing the results. A schematic of the experimental facility is given, as well as flowcharts of the programs for spectral measurements and data processing. Results are compared with data in the literature. Figures 6, references 7: 2 Russian, 5 Western.
[24-6610]

UDC 535.317.1

NEW EXPERIMENTAL RESULTS ON EFFECTIVE USE OF RANDOM-PHASE MASK IN HOLOGRAPHIC MEMORIES

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 3, Sep 81
(manuscript received 27 Mar 80) pp 535-541

AKAYEV, A. and KERIMKULOV, T.

[Abstract] Previous research has shown that the use of a random-phase mask for coding the input page provides an effective means of producing high-quality holographic backing stores. The theory of recording of Fourier holograms for a digital store of this kind based on Rayleigh law of Fourier transform distribution has been effectively used for analyzing results of experiments. However, the question of the validity of the assumption of Rayleigh distribution remains open. Furthermore, experiments have shown that four-level random-phase masks are no more effective than two-level masks, although theory predicts that they should be twice as effective. Another problem that has not been studied is the influence that the information content of the input page has on the dynamic range of its Fourier transform. This paper gives the results of computer experiments by the method of statistical modeling that were designed to answer these questions. The results confirm the validity of Rayleigh law for amplitude distribution of Fourier transforms. It is also demonstrated that the two-level random-phase mask is optimum rather than the four-level mask. A special method is proposed and experimentally verified for forming the input page with relatively high stability of the dynamic range of amplitude of the Fourier transform of the page regardless of content. Figures 4, references 7:
4 Russian, 3 Western.
[21-6610]

UDC 535.317.1

RECONSTRUCTING COMPLEX FIELD AMPLITUDE OF OBJECT OBSERVED THROUGH OPTICALLY INHOMOGENEOUS RANDOM MEDIUM

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 51, No 3, Sep 81
(manuscript received 10 Nov 80) pp 561-563

SVIRIDOV, K. N. and SIDEL'NIKOV, V. N.

[Abstract] Previous research has come up with various approaches to the problem of reconstructing the complex amplitude of the field of an object that has arisen because of difficulties in directly recording the phase of a received light pulse (the "phase" problem of partial coherence theory). Most promising is an iteration procedure based on sequential processing of two distributions of light pulse intensity recorded simultaneously in two different reception planes. When an optically inhomogeneous random medium is situated between the observed object and the telescope aperture, the complex amplitude reconstructed by this approach is randomly distorted. The authors suggest a possible method of compensating these distortions and isolating the complex amplitude of the field of the object. The approach is based on separate statistical averaging of the amplitude and phase of the reconstructed complex amplitude for several independent realizations. To do this, several pairs of distributions of field intensity are recorded during observation in two planes with exposure time equal to or less than the interval of time correlation of fluctuations of the optically inhomogeneous medium. Reconstruction allows the object to be "seen" through optically inhomogeneous random media. References 6: 3 Russian, 3 Western.
[21-6610]

UDC 537.533.331

BOX-LIKE ELECTROSTATIC LENS WITH FOUR PLANES OF SYMMETRY

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 9, Sep 81
(manuscript received 22 Jul 80) pp 1804-1808

GLIKMAN, L. G. and SEKUNOVA, L. M., Institute of Nuclear Physics, KaSSR Academy of Sciences, Alma-Ata

[Abstract] A study is done on the optoelectronic properties of two-electrode box-like electrostatic lenses with four planes of symmetry. Each electrode is made up of four plates held at the same potential, and the potentials of the two electrodes are different in the general case. It is assumed in the calculations that the gap separating the two electrodes is infinitesimally small, and that the length of the generatrix of the plates is infinitely long. Lenses are considered in which the line on each of the sides of the box separating plates of different potentials is a straight line segment, and a semicircle. The field for such an electrostatic system is found by solving the Dirichlet problem

with zero boundary conditions for the potential on three sides of an infinitely long box of rectngular cross section, and non-zero conditions on the fourth side of this box. Analysis of optoelectronic properties is based on the theory of lenses with two planes of symmetry, assuming that the potential is equal to zero wherever particle velocity is equal to zero. Cardinal elements and coefficients of spherical aberration are given at values of linear magnification equal to -1, 0 and ∞. The ratio of potentials on the electrodes $\Phi = \Phi_2/\Phi_1$ was varied so that the quantity $\sqrt{\Phi}$ for accelerating lenses and the quantity $1/\sqrt{\Phi}$ for decelerating lenses took on values in the interval [1.2, 10]. The results of the analysis show that lenses of this type can be used in ottoelectronic systems to produce a correct image of an object with improved focusing in one direction and partial elimination of third-order spherical aberration. They can also be used as correctors of spherical aberration in both directions in optoelectronic systems that contain astigmatic elements. Figures 2, references 3: 1 Russian, 2 Western. [20-6610]

UDC 535.317.25

RESOLUTION OF POLARIZATION-TYPE ELECTRO-OPTICAL DEFLECTOR

Minsk IZVESTIYA AKADEMII NAUK BSSR: SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 4, Jul-Aug 81 (manuscript received 30 Jan 81) pp 79-82

PILIPOVICH, V. A., POLYAKOV, V. I. and KONOYKO, A. I., Institute of Electronics, BSSR Academy of Sciences

[Abstract] An analysis is made of the resolution of a light-deflecting system that is made up of an electro-optical deflector of polarization type that effects parallel displacement of a convergent light beam, and the optical system that produces the light beam. Assuming that all optical elements have a high degree of optical homogeneity, the resolution of the light-deflecting system is determined by diffraction broadening of the light beam and the sum of all aberrations of the illuminating and deflecting systems. The electro-optical deflector is made up of electro-optical polarization selectors and birefringent elements with optical components that are plane-parallel plates. Since the birefringent component in the general case splits a monochromatic light beam into ordinary and extraordinary waves with different indices of refraction, the depth of focusing of deflected light beams is different. Expressions are given for resultant defocusing, transverse and longitudinal positional chromatism, transverse and longitudinal spherical monochromatic abberations. Analysis of these relations shows that spherical aberration of the electro-optical deflector can be disregarded. It is shown that coma is determined by the parameters of the optics that shape the light beam, and that the deflecting system should not introduce astigmatism. Complete aberrational analysis demonstrates that the optical system of the electro-optical deflector has almost no effect on resolution, and that the major contribution to deterioration of resolution is from diffraction broadening of the light beam and spherical aberration of the optics that shape the light beam. It is experimentally verified that resolution can be improved by minimizing these factors. Figure 1, references 4 Russian. [18-6610]

PARTICULARS OF ULTRASHORT INTENSE LIGHT PULSE PROPAGATION IN MULTIMODE OPTICAL FIBERS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 34, No 7, 5 Oct 81 (manuscript received 18 Jul 81, after revision 24 Aug 81)
pp 391-395

NESTEROVA, Z. V., ALEKSANDROV, I. V., POLNITSKIY, A. A. and SATTAROV, D. K.

[Abstract] Nonlinear conversion of laser emission in fiber-optics bundles is attained at anomalously low intensity of the light flux at the input to the bundle. This opens up prospects for studying the mechanism of nonlinear conversion of intense radiation over a wide range of exciting pulse energies. In this paper experiments are done to determine the behavior of nonlinear processes arising in fiber-optics bundles with stimulation by ultrashort light pulses. The time characteristics of light pulses are analyzed by the Agat optoelectronic chamber with time resolution of 2-3 ps. The results show that self-stress of intense laser emission in a multimode fiber-optics bundle leads to a change in propagation conditions with possible self-compression of ultrashort light pulses on frequencies of the Stokes components of stimulated Raman scattering. Detailed studies with equipment having sub-picosecond resolution should reveal the fine points of the process of unsteady stimulated Raman conversion of laser emission in fiber-optics bundles. An analysis should be made of the feasibility of using components of stimulated Raman scattering in such systems for data transmission. Figures 3, references 7: 3 Russian, 4 Western.
[34-6610]

PLASMA PHYSICS

UDC 537.525

EXPLOSIVE MODEL OF ARC-DISCHARGE CATHODE SPOTS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 51, No 9, Sep 81
(manuscript received 21 Apr 80, after revision 22 Sep 80) pp 1809-1811

KRAT'KO, S. A., Scientific Research Institute of Applied Physical Problems at Belorussian State University imeni V. I. Lenin, Minsk

[Abstract] The author proposes a mechanism of explosive vaporization as a basis for unsteady models of cathode spots in an arc discharge. It is assumed that processes of phase explosion of microinhomogeneities are periodically repeated in the cathode spot. A necessary condition for this effect is current density of 10^{10}-$5\cdot10^{11}$ A/cm^2. If this condition is met, resistive heating will increase temperature to the critical point beyond boiling within 10^{-5}-10^{-7} s, after which superheated vapor, liquid and ions will be ejected in 10^{-7} s. It is assumed that the energy or resistive heating is expended on phase explosion and can be disregarded in the general energy balance. The proposed model is confirmed by numerical calculations based on a method of existence diagrams. Figure 1, references 12: 7 Russian, 5 Western.
[20-6610]

UDC 533.951

LONGITUDINAL WAVE AMPLIFICATION IN MODULATED BEAMS: I. FUNDAMENTAL HARMONIC AMPLIFICATION

Moscow FIZIKA PLAZMY in Russian Vol 7, No 4, Jul-Aug 81
(manuscript received 20 Mar 80, after revision 4 Jan 81) pp 764-774

GENDENSHTEYN, L. E. and POLOVIN, R. V., Khar'kov Physicotechnical Institute, UkSSR Academy of Sciences

[Abstract] Previous research on motion of a particle beam through a plasma has shown that premodulation of beam density may result in amplification. In this paper the authors find the band of amplified frequencies and determine the

increments of amplification on the fundamental harmonic for an extensive class of modulations. Passbands for an interrupted beam are found, and an examination is made of jumps in the amplification increment and the effect of "rigid excitation." A subsequent article will deal with combination waves, and it will be proved that the direction of increase in the waves coincides with the direction of propagation, i.e. that amplification occurs rather than non-transmission. The analysis is restricted to waveforms propagating in the direction of beam inhomogeneity, considering the beam and plasma to be infinite and uniform in the other two dimensions. Thus all investigated quantities depend only on time and one coordinate. The linear theory is considered in the case of periodic modulation, the beam and plasma being taken as cold. The following effects are observed: 1. reduction of the increment of amplification as modulation increases for an arbitrary density profile (in the case of partial modulation and large gain); 2. a new passband shows up in the case of a beam of plasmoids of arbitrary shape; 3. jumps in the increment of amplification as a function of frequency; 4. possibility of rigid excitation of oscillations (increment of amplification limited from below). A formula is derived for simple computation of the spectrum and increments of amplification for arbitrary assigned periodic modulation. Figures 3, references 10: 9 Russian, 1 Western.
[19-6610]

HEAT TRANSFER IN TURBULENT LASER PLASMA

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian
Vol 34, No 6, 20 Sep 81 (manuscript received 16 May 81) pp 325-328

BYCHENKOV, V. Yu. and SILIN, V. P., Physics Institute imeni P. N. Lebedev,
USSR Academy of Sciences

[Abstract] It has been realized for some time that the discrepancy between the theory of laminar plasma flows and experimental results can be explained by assuming a transition to the turbulent state due to development of ion-sound instability excited by electronic heat flux with resultant suppression of heat transfer. However, the theoretical investigation of the problem has been hampered by lack of analytical equations showing the relation between the heat flux and temperature gradient in a turbulent laser plasma. In this paper the authors formulate principal equations of turbulent flow of a nonisothermal collisionless plasma. These equations are based on the angular distribution of turbulent fluctuations determined by the authors under conditions where ion-sound turbulence is initiated by intense electronic heat flux. It is shown that for a plasma with developed ion-sound turbulence the thermal conductivity coefficient is inversely proportional to the absolute value of the turbulent heat flux density. This corresponds to a reduction in the effective mean free path of electrons with increasing intensity of turbulent fluctuations. As a consequence of nonlinearity in the relation between heat flux and temperature gradient, there is a considerable reduction in the scale of spatial variation in temperature and other gasdynamic quantities as compared with conventional laminar theory. Estimates show that this scale is of the order of 10^{-4} cm or less. References 12: 3 Russian, 9 Western.
[36-6610]

RESONANT INTERACTION OF PLASMA BEAM WITH EXCHANGELESS MAGNETOSTATIC SURFACE WAVE

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 23, No 9, Sep 81
(manuscript received 10 Feb 81) pp 2580-2586

GULYAYEV, Yu. V., ZIL'BERMAN, P. Ye. and RAYEVSKIY, A. O., Institute of Radio Engineering and Electronics, USSR Academy of Sciences, Moscow

[Abstract] The authors investigate resonant interaction of a surface spin wave in a saturated ferromagnetic with a surface plasma wave in a beam passing over the surface of the ferromagnetic. A dispersion equation for the interacting waves is derived and solved in the exchangeless approximation and in the first order with respect to relativistic parameters $(1/c^2$, where c is the speed of light). There are three resonances for a beam with not too high density. Close to two of these resonances the spectra move apart, while close to the third they tend to merge (the waves synchronize each other), and one of the branches may show instability. This is impeded by dissipation processes and by sticking of electrons to the surface of the ferromagnetic. However, under actual conditions amplification may reach 75 dB/cm in the ferromagnetic-plasma beam structure in a relative band of $4\cdot10^{-3}$ at a frequency of 3 GHz. The width of the resonance line in the ferromagnetic need not be narrow, and in fact may be 10-100 times wider than that necessary for amplification in structures of the ferrite-semiconductor type. The maximum increment of instability occurs when ferromagnetic plates are used with thickness considerably exceeding a wavelength. Sticking and dissipation may have a considerable effect on the form of spectrum of interacting waves, as well as on the condition of instability. Figures 3, references 13: 11 Russian, 2 Western.
[35-6610]

NONLINEAR SATURATION OF STIMULATED MANDELSTAM-BRILLOUIN SCATTERING IN RAREFIED NONISOTHERMAL PLASMA

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 34, No 7, 5 Oct 81 (manuscript received 6 Aug 81) pp 385-388

SILIN, V. P. and TIKHONCHUK, V. T., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] The theory of stimulated Mandelstam-Brillouin scattering as applied to a laser plasma is of interest because of possible resultant limitations of heating efficiency. On the other hand, research has shown that correct calculation of the coefficient of reflection due to induced Mandelstam-Brillouin scattering from rarefied plasma layers requires consideration of nonlinear effects, and in particular the nonlinearity of ion sound for a nonisothermal plasma. Although this kind of nonlinearity was taken into consideration in theoretical studies by Gorbunov et al. [see L. M. Gorbunov, ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI, Vol 65, 2973, p 990;

L. M. Gorbunov, V. I. Domrin, D. K. Salikhov, KRATKIYE SOOBSHCHENIYA PO FIZIKE FIAN, No 9, 1981], there were no changes in the representations of strong scattering. In this paper, the authors show that the process of harmonic generation considered by Gorbunov et al. leads to sharp restriction of stimulated Mandelstam-Brillouin scattering in a rarefied plasma. A system of equations is derived for the electric field amplitudes of the incident and backscattered electromagnetic waves, and the amplitudes of the fundamental and second harmonics of sound waves. An analysis is made of this system in the near-threshold region, assuming that the amplitude of the second harmonic is much smaller than the fnndamental perturbation. The limiting value of the local coefficient of reflection is found, which enables evaluation of the total attenuation of power emission due to stimulated Mandelstam-Brillouin scattering as the emission propagates in a rarefied plasma. It is shown that the reflected flux is a small fraction of the incident energy regardless of the scale of density inhomogeneity. References 12: 7 Russian, 5 Western.
[34-6610]

UDC 533.95

SCIENTIFIC-ENGINEERING APPROACH TO PROBLEM OF MODELING AND ANALYZING PLASMOTRON DYNAMICS AS TECHNOLOGICAL OBJECT: III, ANALYSIS OF DYNAMICS IN CASE OF DISTRIBUTED EXTERNAL FACTORS, METHOD OF DYNAMIC PLASMOTRON OPTIMIZATION

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK: SERIYA TEKHNICHESKIKH NAUK in Russian No 8(338), Issue 2, Jun 81 (manuscript received 12 Feb 81) pp 94-108

BORISKIN, S. P. and DEVYATOV, B. N., Novomoskovsk Affiliate of the State Scientific Research and Design Institute of the Nitrogen Industry and Products of Organic Synthesis

[Abstract] The dynamic characteristics of a plasmotron are analyzed by using the concept of time lags. The radiation of the electric arc is taken into consideration in the analysis as the contribution from this source to the overall energy balance becomes appreciable for plasmotrons of high unit power. The proposed model also contains distributed and lumped-parameter perturbing functions. A method is given for determining lag times of different orders in general form for an industrial plasmotron, and for numerical calculation of these times. Functions of the transient process are analyzed for the individual characteristics of different approximations. It is recommended that the passband determined from lag times of different orders be used to estimate the dynamic properties of the plasmotron on the design stage with and without a control system. Possible amplification of extremum values of lag times of an external factor in the plasmotron could be used to stabilize modes of operation of the device. On this basis, a technique is worked out for dynamic optimization of a plasmotron with chemical reactions. Figures 6, references 35 Russian.
[23-6610]

UDC 537.523.5

CALCULATING LIMITING ENERGIES OF GAS-DISCHARGE FLASHLAMPS

Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK: SERIYA TEKHNICHESKIKH NAUK in Russian No 8(338), Issue 2, Jun 81 (manuscript received 8 Jul 80) pp 134-142

GRADOV, V. M., ZIMIN, A. M., PREOBRAZHENSKIY, V. A., TERENT'YEV, Yu. I. and SHCHERBAKOV, A. A., Moscow Higher Technical Academy imeni N. E. Bauman

[Abstract] Previous research on the limiting energy loads of gas-discharge flashlamps shows a rather complex pattern that reflects a variety of factors responsible for the relation between maximum energy and major lamp parameters. In this paper a theory is proposed that enables relatively simple prediction of limiting energies of lamps on the basis of predetermined structural and electrophysical parameters. It is assumed that the input power pulse is square-wave. Based on a comparison of theoretical and experimental data, an analysis is made of the capabilities of the proposed method of prediction, and the reliability of results is evaluated. A investigation is made of the influence that various factors have on the limiting energies of gas-discharge radiation sources. Figures 6, references 22: 21 Russian, 1 Western.
[23-6610]

UDC 533.7

DEFINITION OF STRONGLY NONIDEAL PLASMA

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 19, No 4, Jul-Aug 81 (manuscript received 21 Mar 80) pp 680-685

IOSILEVSKIY, I. L., Moscow

[Abstract] One of the impediments to the investigation of properties of a nonideal plasma is a lack of an exact definition of the concept of a strongly nonideal plasma, since the parameter conventionally used for this purpose contains an arbitrary and ambiguous quantity--the density of free charges. The author discusses situations where ambiguity of the definition of the parameter of nonideality causes difficulties. It is shown that the difficulties involved in using the conventional parameter of nonideality are not eliminated in a rigorous approach based on plasma expansion with respect to degrees of activity. In the region of $Ry/kT \gg 1$, the smallness of the conventional nonideality parameter $\Gamma \equiv e^2/kTr_D$ (where r_D is the Debye radius) does not in itself guarantee accuracy of the traditional Saha ideal-gas approximation. Figures 2, references 12: 9 Russian, 3 Western.
[24-6610]

UDC 533.951

MODEL OF QUASISTEADY HEAVY INERT GAS BEAM PLASMA: I. GENERAL DESCRIPTION OF MODEL

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 19, No 4, Jul-Aug 81
(manuscript received 30 May 80) pp 709-719

KARLASHOV, A. V. and KORSHUNOV, O. V., Institute of High Temperatures,
USSR Academy of Sciences

[Abstract] A model is proposed for a quasisteady plasma of dense inert gases ($N \sim 10^{19} - 10^{21}$ cm^{-3}) produced by a homogeneous high-energy electron beam. The model describes a plasma with electron concentration of $n_e \sim 10^{14} - 10^{18}$ cm^{-3} and electron temperature $T_e \sim 0.5$-1 eV throughout the range of practically realizable beam current densities. Consideration is taken of the decisive role of the block of excited states in the kinetics and energetics of the plasma electrons. Both collisional processes (depopulation of excited states of atoms and molecules by electron impact) and radiative processes (photodissociation of excimers) are taken into account. The mechanism of excitation energy conversion is analyzed and simple relations are derived for calculating plasma parameters under conditions of total domination of dissociative recombination when processes of triple recombination and photodissociation are insignificant. The next article will deal with the analogous situation when triple recombination or photodissociation predominates, thus covering the entire region of existence of this type of plasma. The influence of nonequilibrium on temperature conditions is discussed. In the mode of total predominance of dissociative recombination, the electron temperature is determined by inelastic collisions with excited particles, does not depend on external factors, and has a minimum value of about 0.4 eV. This is due to the mechanism of energy domination and settling of concentrations of excited and charged particles. References 18: 10 Russian, 8 Western.

[24-6610]

EFFECT OF Ar^+ AND O_2^+ ION INJECTION ON SUPERCONDUCTING PROPERTIES OF NIOBIUM FILMS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 23, No 9, Sep 81
(manuscript received 29 Dec 80, after revision 27 May 81) pp 2858-2860

BELYAVSKIY, Yu. V., VENDIK, O. G., GODAKOV, S. S., KOZYREV, A. B. and SAMOYLOVA, T. B., Leningrad Electrical Engineering Institute imeni V. I. Ul'yanov (Lenin)

[Abstract] Ion implantation is used to study the effect of Ar^+ and O_2^+ on the superconductor properties of Nb films. Since the mass ratio of these ions is close to unity, it can be assumed that the nature of the resultant structural defects will be the same, so that an evaluation can be made of the influence that such factors as structural defects and chemical activity of the dopant have on the superconducting properties of the films. Ion energy was 70-80 keV, and implantation was done at 300 K and pressure of 10^{-4} Pa. Maximum dose was $2 \cdot 10^{16}$ cm^{-2}. The electrical characteristics of the superconducting films were measured by a standard four-probe method after each cycle of irradiation. It was found that the critical pinning temperature in a perdendicular magnetic field at 4.2 K decreases monotonically with increased irradiation dose for either type of ion. The film resistance increases monotonically with increasing dose, and the critical temperature drops. The reduction in critical temperature is stronger for O_2^+ than for Ar^+. The critical magnetic field increases with low doses of Ar^+, passes through a maximum with increasing dose, and then begins to fall. O_2^+ implantation causes a reduction in the critical magnetic field that falls linearly with increasing dose, except in films with the lowest resistance, which show a weaker maximum than in the case of Ar^+. The difference in behavior can be attributed to the greater chemical activity of the O_2^+ ions. Figures 2, references 3: 2 Russian, 1 Western.
[35-6610]

UDC 517.958:536.2

APPROXIMATE SOLUTION OF HEAT CONDUCTION PROBLEM IN PRESENCE OF MOVING HEAT SOURCE

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian
Vol 21, No 5, Sep-Oct 81 (manuscript received 19 Nov 79) pp 1329-1333

OSTROUMOV, A. V., Moscow

[Abstract] In analysis of the thermal dynamics of contact friction the problem arises of determining the temperature field generated by a moving source of heat. In this paper a simple formula is derived for solving this problem. The analysis is based on a model in which a contact spot of fixed shape is in translational motion at given velocity along a line on the surface of a half-space with assigned coefficient of thermal diffusivity. A heat source of given intensity acts within the contact spot. Heat exchange with the external medium is disregarded outside the contact spot. The proposed formula approximates the exact solution of the problem in a contact spot of arbitrary shape when the ratio of the velocity of the spot to the coefficient of thermal diffusivity is large enough. The accuracy of the approximation is evaluated.
[37-6610]

CSO: 1862

- END -

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UDC 539.2

CRITERION OF JUMPWISE LOW-TEMPERATURE PLASTIC DEFORMATION DURING VIBRATIONS

Kiev FIZIKA NIZKIKH TEMPERATUR in Russian Vol 7, No 11, Nov 81
(manuscript received 8 Jun 81) pp 1475-1478

ZHITOMIRSKIY, I. S. and NECHIPORENKO, I. N., Physico-Technical Institute of Low Temperatures, UkSSR Academy of Sciences, Khar'kov

[Abstract] A criterion is established for jumpwise plastic deformation during vibrations at low temperatures. It is based on the uniaxial state of stress and strain of single crystals or polycrystals with plastic flow beyond the yield point and attendant energy dissipation. Combining the equations of heat balance and mechanical vibrations yields the condition of self-excitation as the criterion of jumpwise deformation. Further analysis reveals that fluctuations of the total strain with a period not shorter than the duration of a jump of plastic strain raise the temperature at which such jumps begin to occur. The authors thank A. I. Landau for discussing the results several times. References 9: 8 Russian, 1 Western.
[167-2415]

PHOTOLUMINESCENCE FROM EPITAXIAL GaAs LAYERS AFTER LASER TREATMENT

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 7, 12 Apr 82 (manuscript received 8 Feb 82) pp 436-439

KALANDARISHVILI, K. G., KOVAL'CHUK, Yu. V. and PORTNOY, Ye. L., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] A study was made of the effect of laser treatment on the photoluminescence spectrum of epitaxial GaAs layers produced by the MOS-hydride process or by the molecular-beam process. Specimens of both kinds were annealed with pulses of 3 ns duration from a YAG:Nd^{3+} laser ($\lambda = 1.06$ µm) operating in the Q-switched mode. Photoluminescence was then excited at 77 K with an LG-106M-1 argon laser (principal lines 488.0 and 514.5 nm). The

spectrum most appreciably affected was that of GaAs layers produced by MOS-hydride epitaxy with strong doping, the intensity of the edge band decreasing by two orders of magnitude and the intensity of the 1.29 eV impurity band increasing by a factor of 3, while the spectrum of those with weak doping changed insignificantly after treatment with 0.1 J/cm^2 laser pulses. The spectrum of GaAs layers produced by molecular-beam epitaxy was affected differently, the intensity of the impurity band increasing appreciably but the intensity of the edge band changing hardly at all after treatment with o.4 J/cm^2 laser pulses. The results indicate that it is feasible to alter the luminescence characteristics of crystalline semiconductor layers by short laser pulse action. The authors thank V. B. Smirnitskiy, V. I. Smil'gyavichus, B. S. Yavich and P. S. Kop'yev for assisting in this study. Figures 3, references 4: 1 Russian, 3 Western.
[172-2415]

UDC 535.376.2

PHOTOVOLTAIC CELLS BASED ON $Cu_2S-Zn_xCd_{1-x}S$ HETEROJUNCTIONS MADE BY TRANSFER IN HYDROGEN STREAM

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 3, Mar 82 (manuscript received 20 May 81) pp 519-520

RAZYKOV, T. M., RAZYKOVA, M. A. and AKHMATSHAYKHOV, M., Physicotechnical Institute imeni S. V. Starodubtsev, UzSSR Academy of Sciences, Tashkent

[Abstract] The authors demonstrate the feasibility of making thin-film photovoltaic cells based on solid solutions of A^2B^6 semiconductor compounds, and in particular on the basis of $Cu_2S-Zn_xCD_{1-x}S$ heterojunctions by transfer in a stream of hydrogen. The initial materials were CdS and ZnS powder vaporized into the gas stream from discrete sources, forming a layer of $Zn_xCd_{1-x}S$ solid solution on a molybdenum backing. The Cu_2S barrier layer was produced by chemical treatment in an aqueous solution and by reacting cuprous chloride from the solid phase with the $Zn_xCd_{1-x}S$. Films of $Zn_xCd_{1-x}S$ were produced with different compositions in the range $0 \leq x \leq 1$ doped with indium. X-ray spectral analysis showed a polycrystalline structure of the Würtzite type with c-axis perpendicular to the backing. Studies of the optical width of the forbidden band of the films as a function of composition showed that as x increases the spectral sensitivity of the heterojunction is shifted toward the short-wave region ($0.3<\lambda<0.5$ μm), whereas the photoresponse of the long-wave region ($\lambda>0.9$ μm) remains unchanged. This shows the formation of chalcocite for all heterojunctions regardless of composition of the base. The specimens typically had high spectral sensitivity over the entire band. The form of spectral

dependence of photocurrent was similar to that of Cu_2S-CdS heterojunctions. Cells with optimum base composition in direct sunlight generated emf of 0.55-0.65 V at current density of 14-16 mA/cm^2 with efficiency up to 8%. Figures 3, references 12: 6 Russian, 3 Western.
[160-6610]

UDC 621.382.8:539-216.2

CHANGE IN OPTICAL PROPERTIES OF THIN FILMS RESULTING FROM ION IMPLANTATION

Moscow POVERKHNOST': FIZIKA, KHIMIYA, MEKHANIKA in Russian No 4, Apr 82 (manuscript received 19 Oct 81) pp 87-89

KAMARDIN, A. I. and RADZHABOV, T. D.

[Abstract] An investigation is made of the way that bombardment with different kinds of ions affects the physicomechanical and optical properties of films used as masking coatings in making semiconductor devices. The materials studied include chromium, molybdenum and ferric oxide sputtered films, as well as organic films centrifugally applied to K-8 glass backings. Thickness of the metallic and oxide films did not exceed 0.3 μm, and the organic films ranged in thickness from 0.1 to 2.5 μm. Thickness was measured by the MII-4 interferometer, coefficients of transmission in the visible part of the spectrum were checked on the NU-2E microscope and SF-10 spectrophotometer. Mechanical stability of the films was determined from the critical breaking load by a corundum needle. An ion-beam doping facility was used for ion bombardment. Plots are given for the optical density of films as a function of the dose of irradiation, and as a function of the energy of irradiation with argon ions in a dose of 10^{16} ions/cm^2. A table summarizes the optical and mechanical properties of films exposed to various ions. It is shown that ion bombardment of thin polymer films changes their structure, giving rise to crosslinking that influences the mechanical, chemical and optical properties of the films, and determines the behavior of films of various composition and thickness when exposed to ion bombardment. The proposed technique can be used to modify the parameters of masking layers in predetermined ways for production of semiconductor devices. Figures 2, table 1, references 4: 3 Russian, 1 Western.
[173-6610]

FLUID DYNAMICS

UDC 517.9:532.5

DIFFRACTION OF KLEIN-GORDON INTERNAL WAVES BY HALF-PLANE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 264, No 1, May 82
(manuscript received 25 Nov 81) pp 73-75

GABOV, S. A., Moscow State University imeni M. V. Lomonosov

[Abstract] Small vibrations of an incompressible fluid with density varying exponentially in the direction normal to the direction of plane flow is described by an equation which, upon integration, can be reduced to a Klein-Gordon wave equation. The problem of diffraction of such a wave by a solid wall at infinity is analyzed, asymptotic solutions being found for both "bright" and "shadow" subregions of the wave field. An examination of all diffraction terms reveals an intridate pattern, including an overdamped radial component, attributable to scattering of internal waves. The author thanks A. G. Sveshnikov for supporting this study. Article presented by Academician A. N. Tikhonov 4 November 1981. References 2 Russian.
[170-2415]

UDC 533.6.011

REGULAR REFLECTION OF SHOCK WAVE BY RIGID WALL

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 46, No 2, Mar-Apr 82
(manuscript received 3 Jun 81) pp 225-234

TESHUKOV, V. M., Novosibirsk

[Abstract] Motion of a nonviscous thermally nonconducting gas is considered and, on the basis of a piecewise-analytical solution to the equations of gas dynamics, the reflection of a shock wave by a stationary rigid wall is analyzed. Relations in the shock wave, with a front of arbitrary form, are established for the case of geometrically regular reflection realizable during the first stage. After transformation of the equations and boundary conditions

to new coordinates, in accordance with the applicable Cauchy problem, their solution is sought in the class of formal power series. The existence of an analytical solution in the supersonic case is demonstrated on the basis of convergence of these series, by constructing the majorants of the solution and solving the auxiliary majorant problem. A one-sheeted reflection is demonstrated on the basis of relations in the corresponding Jacobian and by application of the implicit-function theorem. The solutions obtained here describe the complete flow of gas behind the reflected wave, including the flow in its trail. The author thanks L. V. Ovsyannikov for his interest. References 5 Russian.
[179-2415]

UDC 536.255

STEADY-STATE SHAPE OF BODIES DISINTEGRATING DUE TO RADIATIVE HEATING IN HYPERSONIC STREAM

Moscow TEPLOFIZIKA VYSOKIKH TEMPFRATUR in Russian Vol 20, No 2, Mar-Apr 82 (manuscript received 16 Dec 80) pp 283-287

BRYKIN, M. V., Institute of High Temperature, USSR Academy of Sciences

[Abstract] The steady-state shape of the frontal surface of bodies disintegrating due to radiative heating in a hypersonic stream is defined as the shape which, in a system of coordinates fixed with respect to the body, does not change during the ablation process. Various determinations of this shape have been made for blunt axisymmetric bodies by numerical methods, inasmuch as adequate analytical expressions for the radiation flux distribution over the body surface are not available. The main problem is to establish satisfactory empirical relations. It has been assumed that the disintegration rate is proportional to the incident thermal radiation flux, with the necessary condition for steadiness of shape thus being that $q_w/q_x^0 - \cos\theta(x)$ (q_w^0- radiation flux at stagnation point, q_w = radiation flux at any surface point, $\theta(x)$-angle between direction of oncoming hypersonic stream and normal to body surface at point x, x- longitudinal coordinate on surface with origin at stagnation point), and that ablation does not significantly distort the original radiation flux distribution. Data have been obtained by this and other authors for spheres and blunt cones in an adiabatic shock layer of equilibrium air at stream velocities $N_{M,\infty} = 20$ and 60. The results are difficult to compare and correlate, especially since convective heating also occurs and must be taken into account. The author thanks L. M. Biberman and S. Ya. Bronin for continuous interest in this study and helpful discussions. Figures 4, table 1, references 14: 10 Russian, 4 Western.
[180-2415]

LASERS AND MASERS

COAXIAL PUMPING OF GAS LASER WITH HIGH-POWER FOCUSED PROTON BEAM

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 7, 12 Apr 82 (manuscript received 11 Jan 82) pp 385-388

SULAKSHIN, S. S. and TOLOPA, A. M., Scientific Research Institute of Nuclear Physics, Tomsk Polytechnic Institute

[Abstract] Coaxial pumping of Ar-N_2 and XeCl (He-Xe-CCl_4) gas lasers with a linearly focused proton beam was tried experimentally for the first time, using a magnetically insulated diode. The latter consisted of a cylindrical "squirrel cage" cathode 13 mm in diameter coaxially inside a cylindrical anode with a radial gap of 1-1.5 cm between them. The insulating azimuthal magnetic field was produced by a current flowing from an external battery along the cathode. A perforated polyethylene insert lining the inside surface of the anode served as source of a proton emitting plasma. The diode was placed on a TONUS high-current particle accelerator operating in the reverse mode. Emission was recorded in both mixtures: in Ar:N_2=80:20 under p = 1.5 atm at λ = 337.1-380.5 nm (energy 0.45 J, efficiency 0.8%) and in He:Xe:CCL_4 = 3000:400:4 under p = 2 atm at λ = 308 nm (energy 1 J, efficiency 0.37%). The authors thank A. N. Didenko and V. M. Bystritskiy for formulating the problem and supporting the study, also V. G. Tolmachev for participating in the experiment. Figures 2, references 7: 5 Russian, 2 Western.
[172-2415]

UDC 621.373.5

DYE LASER WITH OPTICAL PUMPING AT PULSE REPETITION RATES UP TO 50 HZ

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 36, No 4, Apr 82 (manuscript received 13 May 81) pp 674-676

ALEKSEYEV, V. A., MIKHALINA, T. I., NIKIFOROV, V. G. and SOPIN, A. I.

[Abstract] The emission characteristics of a dye laser with optical pumping were studied, for the purpose of finding ways to increase its average power and decrease its divergence. Three different configurations of lamp and active

medium inside the reflector shell were tried: 1) lamp and one dye cell ($0.85\ cm^3$) cooled simultaneously, 2) lamp and one dye cell ($0.85\ cm^3$) with only the lamp cooled, 3) lamp and two dye cells (total volume 0.85 or $1.7\ cm^3$) with only the lamp cooled. For cooling the lamp only the latter was placed inside a quartz tube. Optical resonators were formed by plane dielectric mirrors optimally matching the dyestuff. Curves depicting the dependence of emission energy on pumping energy up to 50 J and the dependence of average emission power on pulse repetition rate up to 50 Hz, on the basis of measurements, indicate that the second configuration is most efficient. Use of two dye cells with independent resonators makes possible emission at two wavelengths simultaneously. In the experiment with separate ethanol solutions of Rhodamine-6G and 9-diethyl-aminobenzophenoxy-azinon-5 in optimum concentrations yielded laser emission of 1.5 W at the 595 nm wavelength and 1 W at the 665 nm wavelength with a pulse repetition rate of 50 Hz. Figures 2, reference 1 Russian.
[171-2415]

UDC 535.33:628.328.325

SPECTRAL ENERGY CHARACTERISTICS OF FREE EMISSION IN NEODYMIUM GLASSES AT ELEVATED TEMPERATURES

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 36, No 4, Apr 82 (manuscript received 25 May 81) pp 599-603

DANIL'CHUK, N. V. and SHAPOVALOV, V. N.

[Abstract] A systematic study was made of free emission in neodymium glasses (phosphate grades GLS21-24 and KGSS-1621-1, silicate grades GLS1-4, germanate grade KGSS-101, lead-phosphate grades KGSS-F628 and KGSS-F628-3, quartz glass), namely the temperature dependence of its energy and spectrum over the 300-600 K range and in some cases up to 750 K. Tests were performed in the monopulse mode, using active media 10 mm in diameter and 130 mm long with multilayer dielectric coatings placed inside an illuminator-furnace. The data are interpreted on the basis of equations for a four-level system with population inversion. The results indicate a strong dependence of the spectrum position and width on the excess above threshold and on the temperature of the active medium. Selective absorption from thermally populated $^4I_{11}/2$ Stark components reduces both output energy and efficiency of emission while shifting and narrowing the spectrum. It thus appears feasible to control the emission spectrum by varying the temperature of the active medium. The author thanks M. N. Tolstoy for helpful discussion of the results. Figures 3, references 8 Russian.
[171-2415]

UDC 621.373.536

CUTOFF REPETITION RATE OF LASER ON PHOSPHATE-NEODYMIUM GLASS

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 36, No 4, Apr 82 (manuscript received 19 May 81) pp 568-574

ALEKSEYEVA, V. A. and KHANKOV, S. I.

[Abstract] The cutoff repetition rate of a neodymium laser is determined on the basis of its dependence on such limiting factors as strength of active medium, thermal deformation of resonator, temperature rise above threshold, cooling intensity and thermal reduction of gain. General relations are derived for the stationary temperature field of a cylindrical active medium with uniform internal heat generation and steady heat dissipation through the lateral surface. The cutoff repetition rate as well as the emission cutoff temperature have been calculated for a laser on grade GLS 22 phosphate-neodymium glass. The necessary coefficients have been determined on the basis of experimental data for this glass as well as other grades (GLS 23, GLS 24, also KGSS 1111 and KGSS 083) using mirrors with various radii from 0.20 to 0.79 cm, these data fitting the theoretical relations within 10%. The results are useful for design of laser cooling as a function of operating parameters. Figures 2, references 12 Russian.
[171-2415]

NONLINEAR OPTICAL EFFECTS IN PLASMA OF LASER SPARK IN FIELD OF NANOSECOND PULSES FROM Nd:YAG LASER

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8, 26 Apr 82 (manuscript received 25 Dec 81) pp 497-502

BRODNIKOVSKIY, A. M., GLADKOV, S. M., ZADKOV, V. N., KARIMOV, M. G. and KOROTEYEV, N. I., Moscow State University imeni M. V. Lomonosov

[Abstract] Second-harmonic generation with efficient coherent "nonresonant" four-photon processes as well as efficient "nonresonant" generation of anti-Stokes signals were observed in the plasma of a laser spark in two series of experiments involving breakdown of gases (air, argon, carbon dioxide, sulfur hexafluride) under atmospheric pressure by focused nanosecond pulses from a low-power (10 kW) Nd:YAG Q-switched laser. These nonlinear optical effects are attributed, respectively, to quadratic "Lorentz" nonlinearity of the electron component in the plasma, with spatially nonuniform distribution of free electrons in the spark, and to changes in the nonlinear optical characteristics of the gaseous medium upon appearance of the electron component after

breakdown. Optical breakdown was not found to significantly alter the form and the position of Raman scattering spectra of molecular gases involved in these experiments. The authors thank S. A. Akhmanov for support and stimulating discussions. Figures 2, references 15: 4 Russian, 11 Western.
[178-2415]

SELF-EXCITED FLUCTUATIONS DURING INTERACTION OF LASER BEAM AND SOLID TARGET SURFACE IN GASEOUS ATMOSPHERE UNDER ELEVATED PRESSURE

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8, 26 Apr 82 (manuscript received 27 Oct 81) pp 481-485

UGLOV, A. A. and IGNAT'YEV, M. B.

[Abstract] The theoretically predicted self-oscillatory variation of the transmission coefficient in a laser plasma cloud near the surface of a solid target was confirmed in an experiment with a neodymium pulse laser (radiation flux density approximately $3\cdot10^6$ W/cm^2) and a copper target (approximately 0.5 mm thick with a beam hole approximately 100 μm in diameter) in an atmosphere of nitrogen (10-100 atm) and carbon dioxide (10-50 atm). Measurements by the method of longitudinal transillumination have established a relation between the fluctuation parameters of the transmission coefficient and the pulse form of the laser radiation. The results are interpreted qualitatively in terms of heating and evaporation with attendant erosion and shielding effects, the plasma providing negative feedback between laser beam and target surface. Quantitative estimates are made, disregarding the effect of capillary and gravitational forces at the beam hole. At a sufficiently high radiation flux density ($5\cdot10^7$ W/cm^2) the self-oscillatory variation of the transmission coefficient was found to cease, owing to breakdown of the gas, and the mode of its subsequent variation to depend on the evolution of the plasma cluster at the surface. Figure 1; references 10: 9 Russian, 1 Western.
[178-2415]

POSSIBILITIES OF MORE EFFICIENT GENERATION OF ELECTRIC CURRENT BY LASER RADIATION

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8, 26 Apr 82 (manuscript received 29 Jan 82) pp 472-478

ASKAR'YAN, G. A. and RAYEVSKIY, I. M., Institute of Physics imeni P. N.Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Conversion of laser radiation to electric current at a target has important applications in high-temperature physics research as well as in long-distance energy transmission. The efficiency of such conversion is still very low, of the order of 10^{-2}%, as compared with that of conversion of microwave energy (15%). Here the causes of this inefficiency are analyzed on the basis of an equivalent resistive-inductive circuit representing the target with hot plasma and the collector with a load. Both pulse and integral efficiency of energy conversion are calculated, taking into account the pulse shape of the emission emf and that of the generated current. In an experiment with a neodymium laser, a focusing lens, and a cylindrical copper target inside a hollow cylindrical copper collector pulses were produced with 150 MW power and 22 ns duration (referred to half-power level). It has been found feasible to increase the conversion efficiency by effectively decreasing both resistance and inductance of the equivalent circuit as well as the time constant of the emission emf, by tailoring pulses and eliminating feedback. This method should be equally applicable to radiation from a CO_2 laser. Figures 2, table 1, references 11: 5 Russian, 6 Western.
[178-2415]

HIGH-EFFICIENCY PICOSECOND PULSE LASER BASED ON CONCENTRATED NEODYMIUM-PHOSPHATE GLASS

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8, 26 Apr 82 (manuscript received 23 Dec 81) pp 465-468

VISHCHAKAS, Yu., GUL'BINAS, V., KABELKA, V. and SYRUS, V., Institute of Physics, LiSSR Academy of Sciences, Vilnius

[Abstract] An experimental study was made on the feasibility of generating very short high-energy laser emission pulses with concentrated neodymium-phosphate glass as active medium. The equipment included a 1.8 m long resonator cavity between two wedge-shaped dielectric mirrors with reflection coefficients 99.9 and 50% respectively, a stabilizing 1:2 telescope inserted into this cavity, an IFP-800 flash lamp for pumping, a vessel through which a

solution of 3274 modulating dye in isobuthyl alcohol was pumped from mode locking, a negative lens before the amplifier for better utilization of the active medium and prevention of large-scale self-focusing of the beam, and a positive lens behind the amplifier for compensating the beam divergence. With a pumping energy of 300 J, trains of laser pulses were generated with 20 mJ energy and picosecond duration at a 20 Hz repetition rate. Single pulses were extracted with 7 ps duration and average 1.0 mJ energy. The experiment also included statistical measurements and conversion of fundamental radiation (λ = 1.06 μm) to second and third harmonics by means of KDP (potassium-deuterium phosphate) or $LiIO_3$ crystals. In the latter case effective stimulated Raman scattering was recorded with a total energy appreciably exceeding that of the second-harmonic emission. Figures 2, table 1, references 5: 4 Russian, 1 Western.
[178-2415]

SIMPLE DYE LASER WITH DISTRIBUTED FEEDBACK AND EMISSION LINEWIDTH OF 0.01 cm^{-1}

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8, 26 Apr 82 (manuscript received 14 Dec 81) pp 460-462

IL'ICHEV, N. N., MALYUTIN,A.A., PASHININ, P. P., RASPOROV, S. F. and SUKHODOL'SKIY, A. T., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] A simple optical system is proposed for lasers with distributed feedback and narrow-band single-mode emission. The dynamic amplitude-phase array is produced by interference of two beams, one of them formed by reflection from a plane mirror. In an experiment using Rhodamine-6G as the active medium, a high-concentration neodymium-phosphate (glass) laser as the master oscillator and an LiF crystal with F_2 centers as Q-switch, emission was obtained within a 0.01 cm^{-1} narrow band. Placement of a positive lens at a distance of about one focal length from the mirror (50 cm) reduced the diffractive divergence to about 1 mrad and the emission threshold to 10 kW. In addition to its simplicity and that of the tuning mechanism, the main advantages of this system are unilateral emission without adjustment of the pumping beams and elimination of costly diffraction gratings. It could provide a useful tool for nonlinear spectroscopy requiring two laser beams with adjustable frequency separation. Figures 2, references 4 Russian.
[178-2415]

COMPUTER-AIDED SYNTHESIS OF FOCUSING ELEMENTS FOR CO_2 LASER

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8, 26 Apr 82 (manuscript received 2 Feb 82) pp 449-451

GOLUB, M. A., DEGTYAREVA, V. P., KLIMOV, A. N., POPOV, V. V., PROKHOROV, A. M., SISAKYAN, YE. V., SISAKYAN, I. N. and SOYFER, V. A., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Computer-aided synthesis of holograms is useful for producing unconventional optical devices such as light beam focusing elements. Two kinds of "kinoforms" with smooth phase variation over each ring have been developed by these authors on this basis for a light beam at the 10.6 μm wavelength from a CO_2 laser. One of them with a focal length of 30 cm, an analog of a conventional spherical mirror, focuses the beam to a point. The other focuses the beam into a flat ring 25 cm in diameter at a distance of 30 cm. Figures 2, references 6: 4 Russian, 2 Western.
[178-2415]

CO_2 PULSE LASER WAVEFRONT REVERSAL BY FOUR-WAVE INTERACTION IN SULFUR HEXAFLUORIDE

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 8, 26 Apr 82 (manuscript received 27 Oct 81) pp 451-455

BASOV, N. G., KOVALEV, V. I., LESIV, A. R. and FAYZULLOV, F. S.

[Abstract] Feasibility of wavefront reversal of middle-infrared laser radiation by four-wave interaction was demonstrated quantitatively by photographic recording of the field distributions in both signal wave and reversed wave. In the experiment the beam from a CO_2 pulse laser on the P(22) line ($\nu \approx 924.4$ cm^{-1}) was split by a plane mirror into a signal wave and a reference wave. The latter was reflected by another plane mirror, the second reference wave being formed as a result. With the aid of two other plane mirrors, the signal wave was superposed on both reference waves inside a cell containing SF_6 under a pressure of about 150 mm Hg. The relation between accuracy of reversal and divergence of the signal wave indicates that, within experimental accuracy, 100% reversal is possible with an effective reflection coefficient up to 40% in terms of power and up to 10% in terms of energy. The authors thank B. Ya. Zel'dovich, M. A. Musayev and V. V. Shkunov for helpful discussions. Figures 3, table 1, references 6: 2 Russian, 4 Western.
[178-2415]

UDC 621.373

NEW SCHEMES OF LASER TRANSITION EXCITATION

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 3, Mar 82
(manuscript received 26 May 81) pp 521-522

ANTIPENKO, B. M., MAK, A. A., SINITSYN, B. V., RABA, O. B. and UVAROVA, T. V.

[Abstract] Lasing is reported on new transitions of the Er^{3+} ion (${}^4F_{9/2} \rightarrow {}^4I_{11/2}$, ${}^4F_{9/2} \rightarrow {}^4I_{13/2}$) in the $BaYb_2F_8:Er^{3+}$ crystal (8% of Yb^{3+} sites) excited by cooperative processes of step-by-step sensitization. Pumping radiation was provided by a GLS-22 neodymium glass laser placed in a cylindrical illuminator made of diffusely scattering MS-14 glass. The optical cavity was formed by dielectric mirrors with selective reflectivity of 99.5, 88 and 99.5, 99.5% respectively on wavelengths of the transitions ${}^4F_{9/2} \rightarrow {}^4I_{11/2}$ and ${}^4F_{9/2} \rightarrow {}^4I_{13/2}$. An analysis is made of the scheme of energy levels of the Er^{3+} and Yb^{3+} ions that take part in the lasing process. The results of this study demonstrate the realistic feasibility of efficient solid-state lasers with fundamentally new cooperative schemes of excitation of laser transitions. Figure 1, table 1, references 2: 1 Russian, 1 Western.
[160-6610]

UDC 533.9.01

STRUCTURE OF TURN-OFF SHOCK WAVES IN PLASMA

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 23, No 2, Mar-Apr 82 (manuscript received 10 Jun 80) pp 32-37

DANILOV, A. V., Chair of Quantum Theory

[Abstract] Propagation of a plane steady turn-off slow shock wave along the axis of a simple completely ionized plasma is considered, the equations describing it being the same as for a turn-on wave but the boundary conditions being different: existence of a transverse component of the magnetic field corresponds to minimum entropy and turn-off is possible at any inclination angle of the magnetic field. The structure of the wave front is determined on the basis of the equations of two-fluid hydrodynamics and heat transfer for ions and electrons, and their asymptotic analysis. One parameter in the solution is the degree of magnetization of both ions and electrons, the problem being solved for the two extreme cases of completely nonmagnetized and completely magnetized plasma. Supersonic and subsonic flow before the wave front are considered. The decrement of magnetization within the wave front, a characteristic feature of all slow waves, is found to be particularly appreciable in the case of a turn-off shock wave with subsonic flow both before and behind the front. The author thanks A. L. Velikovich and M. A. Liberman for formulating the problem and assisting in the work, also I. M. Lifshits for discussing the results. Figures 2, references 9: 6 Russian, 3 Western. [168-2415]

UDC 629.7.064.58

NUMERICAL SIMULATION OF MHD-GENERATOR PERFORMANCE IN ELECTRIC POWER PLANT UNDER VARIABLE LOAD

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82 (manuscript received 20 Jan 80) pp 347-358

BITYURIN, V. A., IVANOV, P. P., KORYAGINA, G. M., LYUBIMOV, G. A., MEDIN, S. A., MOROZOV, G. N. and PROKOP, A. S., Institute of High Temperatures, USSR Academy of Sciences

[Abstract] Performance of MHD generators in an electric power plant is analyzed by numerical simulation, the object being optimization of the performance under variable load and, particularly, ensuring maximum economy under partial loads. Regulating the flow rate of combustion products at the compressor, in combination with faster regulation of the electrical load at almost constant pressure in the combustion chamber, is found to be the best method of performance control and has been selected as basis for this study. Three types of MHD generator are considered with respectively optimum channel geometry: 1) Faraday generator with fully developable supersonic flow, 2) Faraday generator with limitation to subsonic flow, 3) frame generator with supersonic flow and with diagonal connection of electrodes limited to angles $\alpha \geqslant 30^\circ$. The performance of the MHD generator must match that of compressor, combustion chamber, and air preheater as well as that of steam generator and steam turbine. There is also a cooling system for both combustion chamber and MHD generator, which must be included in the analysis. For such a system, with nominal performance curves available, power-efficiency curves and other characteristics have been calculated corresponding to a 23% downward regulation of the flow rate of combustion products (190-140 kg/s in 20 kg/s steps). The specific fuel consumption (kg/kWh) increases by not more than 3-4%. Figures 9, tables 3, references 14: 13 Russian, 1 Western.
[180-2415]

UDC 533.9.082.76

INVESTIGATING BOUNDARY LAYERS IN MHD-GENERATOR PLASMA BY ELECTRIC PROBE

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82 (manuscript received 9 Jan 81) pp 229-235

BATENIN, V. M., VASIL'YEVA, I. A. and KOSOV, V. F., Institute of High-Temperature Physics, USSR Academy of Sciences

[Abstract] In order to fill a gap in experimental data, boundary layers in the plasma of U-25 and U-25B MHD generators at the Institute of High-Temperature Physics were measured with an electric current probe. Conditions in the two generators were tentatively estimated as follows: stream velocity 100 and 850 m/s, gas pressure 1 atm in both, plasma temperature 2300 and 2600 K, electron concentration 10^{13} and 10^{14} cm^{-3}, channel wall temperature 500 and 700 K, radius of cylindrical probe 1 mm in U-25 generator channel with circular cross section 550 mm in diameter and 1.7 mm in U-25B generator channel with rectangular cross section of 340x1140 mm. A potassium salt was used as ionizable additive in the $0.8N_2 + 0.2H_2O$ mixture. Both probes were made of stainless steel, including the electrodes, a double-cylindrical used for the U-25B generator. They were inserted into the plasma and moved around for a duration of 0.2-0.5 s, their position in space and time recorded during measurements along with their temperature. Processing of the data in accordance with the $I = \text{const}(D,V)^{\frac{1}{2}}n_e$ relation (D - diffusion coefficient, V - stream velocity, n_e - electron concentration), assuming negligible recombination of charged particles at the probe surface, yielded the distribution of ion current over the boundary layer. In addition, temperature and velocity profiles were obtained fitting closely the $\frac{1}{7}$th-power law. The authors thank V. I. Stankevich and I. A. Kiselev for assisting with the experiments, also M. S. Benilov, V. A. Zhelin and V. D. Semenov for helpfully discussing the results. Figures 5, tables 2, references 10: 7 Russian, 3 Western.
[180-2415]

HYPER-RAMAN SCATTERING OF LIGHT BY POLARITONS IN LIQUID CARBON TETRACHLORIDE

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 35, No 8, 20 Apr 82 (manuscript received 11 Feb 82) pp 312-314

DENISOV, V. N., MAVRIN, B. N., PODOBEDOV, V. B. and STERIN, Kh. Ye., Institute of Spectroscopy, USSR Academy of Sciences

[Abstract] A study was made of hyper-Raman scattering by vibrational polaritons in a liquid. The necessary condition for dependence of the polariton frequency on the scattering angle, namely occurrence of transverse and longitudinal dipole vibrations with a wide transverse-longitudinal split, was found to exist in liquid CCl_4. The scattering spectrum and the polariton dispersion were measured at scattering angles from 0 to 3°, with the scattered light passing through annular diaphragms and collected at 0.4° angles equal to the divergence angle of the exciting radiation beam. The results agree closely with theoretical calculations and data on infrared spectra. They reveal a group velocity of polaritons much lower than the velocity of light and thus indicate that thermal motion of molecules in the liquid does not appreciably decrease the wave vector of polaritons during scattering of light. Figures 2, references 8: 6 Russian, 2 Western.
[169-2415]

FOCUSING HIGH-CURRENT RELATIVISTIC ELECTRON BEAM WITH HIGH TIME RESOLUTION

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 35, No 8, 20 Apr 82 (manuscript received 13 Mar 82) pp 332-334

GORBULIN, Yu. M., ZLOTNIKOV, D. M., KALININ, Yu. G., SKORYUPIN, V. A. and SHASHKOV, A. Yu., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] An experimental study was made of the dynamics of a focused high-current relativistic electron beam in the diode of an electron accelerator, with power fluxes of $6 \cdot 10^3$ W/cm^2 density at current densities up to 80 MA/cm^2. Measurements were made in a "Mirazh" test stand, using photographs of the focal spot taken in hard X-rays with time resolution and image converters with direct image transfer. Oscillograms reveal an initial sharp focusing for 50-60 ns, followed by defocusing due to increasing high-frequency oscillations of the unstable diode current with a period of a few nanoseconds. A focused electron beam changes its location on the anode with time and the foil segment it has heated up cools down in its wake. Therefore, the mean surface temperature of the whole focal spot is lower than it would be if the whole spot were heated throughout the entire duration of a pulse. This was pointed out by L. I. Rudakov. Figures 3, references 3: 1 Russian, 2 Western. [169-2415]

OPTICS AND SPECTROSCOPY

UDC 551.573

TRANSILLUMINATION OF HOT SOLID AEROSOL BY HIGH-INTENSITY LIGHT BEAM

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 36, No 4, Apr 82
(manuscript received 22 May 81) pp 557-562

BUKATYY, V. I., TEL'NIKHIN, A. A. and SHAYDUK, A. M.

[Abstract] Transillumination of monodisperse solid aerosol is analyzed in the case where such an aerosol consists of burning particles such as soot, smoke, or metal particles. A light beam of high intensity and small divergence passes through the plane boundary of the half-space occupied by aerosol. Subsequent propagation of this beam is first considered assuming a steady beam and a stationary medium. The corresponding equations are then solved including both light beam dynamics and motion of the medium. The effects of wind are subsequently added, but the effects of diffusion and convection are found to be negligible. The problem reduces to an integral equation, with the burning time in the kernel, which can be solved with the sid of a Laplace transformation and the convolution theorem. Figures 2, references 6 Russian.
[171-2415]

UDC 551.508.2

ABSORPTION COEFFICIENT OF VARNISH-PAINT COATINGS ON THERMAL-TYPE RADIATION RECEIVERS

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82
(manuscript received 19 Jan 81) pp 394-396

KMITO, A. A., SEREDENKO, M. M., PARFINSKIY, V. A., RUSAKOV, V. V., LIBERMAN, A. A. and KARPETS, A. P., Main Geophysical Observatory imeni A. I. Voyeykov, Leningrad

[Abstract] Maximum reproducibility of radiation measurement units is achievable with absolute receivers, not absolute radiators, according to the

relation $E = \frac{i^2 r}{\alpha F} AB$ (E- energy of incident solar radiation, i^2r- equivalent electric power, α- integral absorption coefficient, F- receiver surface area). The correction factors A and B account respectively for varying thermal resistance of the receiver coating and varying heat transfer from receiver to ambient medium. The contribution of both variations to the measurement error can be greatly reduced by use of thermal-type receivers with cooling. The measurement error is then determined by the error in the absorption coefficient. Systematic periodic studies have been undertaken to determine the absorption characteristics of black varnish-paint coatings and, subsequently, ensure stability of their optical properties. Available data on the reflection coefficient of AK-243 paint, Parsons varnish and ZM varnish indicate that its magnitude at various wavelengths does not depend on the coating process but does appreciably depend on the coating thickness. This dependence is an exponential one, according to the Gurevich-Kubelka-Munk theory. For further study, water-soluble coatings were produced by the electrodeposition process, rather than by spray or with brush, to ensure uniform and reproducible thicknesses. On the basis of commercially available film forming pigments and fillers, compounds were formulated with specular reflectivity and minimum spectral selectivity. Four specimens were thus produced with an absorption coefficient $\alpha = 0.99953-0.99991$, based on averages of three series of five readings for each, over the $\lambda = 0.5-10.6$ μm range of the spectrum. This corresponds to a selectivity not exceeding 0.05%. The measurement error did not exceed ± 0.00003 at each wavelength (0.5, 0.63, 1.15, 10.6 μm). Figures 2, table 1, references 5 Russian.
[180-2415]

UDC 535.36

CALCULATING ANGULAR AND SPECTRAL SELECTIVITIES OF HYPERSONIC REFLECTION HOLOGRAM

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52. No 3, Mar 82
(manuscript received 3 Aug 81) pp 504-510

VASIL'YEV, M. V. and SIDOROVICH, V. G.

[Abstract] Electrostrictive interaction between matter and the interference pattern produced by radiation that excites stimulated Mandelstam-Brillouin scattering (SMBS) and by radiation scattered in matter sets up a hypersonic reflection hologram. In this paper, the theoretical analysis is made of the angular and spectral selectivities of the hypersonic gratings that form the SMBS mirror in a wavefront reversal configuration. The BESM-6 computer is used with a program written in GDR-Algol to calculate curves of angular selectivity of the hypersonic hologram for different increments in gain of the

Stokes wave in the field of the stimulating radiation. Comparison of the throretical curves with experimental plots of angular selectivity gives the increment in gain of the Stokes wave in the investigated material. It is shown that a double increment in the Stokes wave with reversed wave front is due to pairwise coherent summation of contributions that are made by components of the SMBS mirror of hypersonic gratings to each planar component of the Stokes wave. This paper was read in June 1981 at a seminar on three-dimensional and dynamic holography organized by the Scientific and Technical Society imeni A. S. Popov in Kiev. Figures 5, references 11: 8 Russian, 3 Western.
[160-6610]

UDC 538.3

STIMULATED MANY-PHOTON EFFECTS ON DIFFRACTION GRATING

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 3, Mar 82
(manuscript received 11 May 81) pp 554-556

OGANESYAN, S. G. and YENGIBARYAN, V. A., Yerevan State University, Scientific Research Institute of Physics of Condensed Media

[Abstract] An examination is made of stimulated effects that arise when a particle passes over a diffraction grating. The depth of modulation of the electron beam and broadening of its energy spectrum are proportional to the number of lines, which may be of the order of 10^5 in good gratings. It is assumed that a charged particle passes at a given distance above a diffraction grating with given period and gap width. A monochromatic electromagnetic wave linearly polarized along the axis parallel to the lines of the grating is normally incident on the lower surface of the grating. A theoretical analysis of the problem is given in the classical and quantum formulations. It is shown that the only electron taking part in stimulated processes are those at a distance of $z_0 \sim \lambda(E/mc^2)$ from the grating surface. For nonrelativistic energies, the total number of interacting particles can be increased by focusing the beam above the grating surface. For relativistic particles, if $\lambda = 1$ µm, $E = 500$ MeV, then $z_0 \cong 1$ mm. Estimates of the power of electromagnetic radiation needed for increasing electron energy by 10% give 2.68 kW/cm^2 for nonrelativistic particles ($\beta = 0.1$), 120 MW/cm^2 for energies $E = mc^2$, and $67 \cdot 10^{13}$ W/cm^2 for relativistic particles $E = 500$ MeV. References: 4 Russian.
[160-6610]

UDC 535.317.1

USING PULSED RUBY LASER FOR HOLOGRAPHIC INTERFEROMETRY OF ROTATING OBJECTS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 3, Mar 82
(manuscript received 13 Jul 81) pp 577-578

MOROZOV, N. V. and OSTROVSKIY, Yu. I., Physicotechnical Institute imeni
A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] In a previous paper [N. V. Morozov, Kh. P. Alum, Yu. N. Ostrovskiy, ZHURNAL TEKHNICHESKOY FIZIKI, Vol 51, 1981, p 355], a method of holographic interferometry was considered in which Lippmann holograms of a rotating object were made with the recording medium secured to the axis of rotation. Since the object and photographic plate make hundreds of revolutions during exposure, severe requirements are imposed on alignment of the optical system and permissible wobble of the axis of rotation. The maximum permissible angle of deviation of the axis of rotation from the normal to the wave front of the illuminating wave is given by $\alpha_{cr} = \lambda/4d \tan \beta$, where λ is wavelength, d is distance between the object and photographic plate, and β is the angle between the normal to the plate and the direction of light scattered by the surface of the object. These requirements can be appreciably reduced if we limit the angle $\Delta\phi$ through which the object and plate turn during exposure. In this paper, an analysis is made of the change in path difference between references and object beams in the space of registration as the plate and object turn about an axis of rotation in the case of illumination by a parallel beam. The result shows that $\alpha_{cr} = \arcsin (\lambda/4d \tan \beta \sin (\Delta\phi/2))$. Experiments were done in which the cw laser was replaced by a pulsed laser to limit the angle of turn during recording of the hologram. Since the duration of the illumination pulse was a few periods of oscillations of the object, the result is time-average interferometry (Powell-Stetson method). The proposed technique relaxes requirements for wobbling and alignment by a factor of about 40 as compared with cw lighting. Figures 3, reference: 1 Russian.
[160-6610]

UDC 778.38:621.397.132

SELECTING LASER EMISSION WAVELENGTHS TO GET HOLOGRAPHIC COLOR IMAGES

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 25, No 3, Mar 82 (manuscript received 28 Oct 80) pp 79-82

BUYMISTRYUK, G. Ya. and DMITRIYEV, A. Ya., Novosibirsk Electrical Engineering Institute of Communications

[Abstract] The author discusses the problem of selecting laser wavelengths to optimize image color quality when using three monochromatic light sources in color holography. The analysis is based on consideration of some specific aspects of color transmission of lighting sources and human color vision, and specifically the peculiarities of metarism. It is found that color stimuli that are metameric under conditions of direct observation have different intensities (intersections) in narrow spectral zones near wavelengths of 450, 540 and 610 nm. It is concluded that metameric identity of the colors of image and object in color holography can be achieved by using lasers that emit on these wavelengths. It is demonstrated that the proposed wavelengths represent an optimum compromise among the colorimetric,holographic and energy parameters in three-beam holography. Figures 2, table 1, references 7: 4 Russian, 3 Western.
[164-6610]

UDC 537.533.3

CHOOSING OPTIMUM RELATION AMONG MAJOR PARAMETERS OF OBSERVATIONAL DEVICE WITH IMAGE CONVERTER TUBE

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 25, No 3, Mar 82 (manuscript received 1 Sep 81) pp 83-88

AVDEYEV, S. P., Leningrad Institute of Precision Mechanics and Optics

[Abstract] An analysis is made of the problem of optimizing the match of parameters of all components of an observational device with image converter tube with required linear resolution with respect to the field and required threshold contrast of the image on the photocathode in a predetermined energy situation under given conditions of observation: given characteristics of the separating media, recording device and objective lens, and conditions of registration of the image from the screen of the image converter tube, e.g. the level of screen lighting by external sources and the rate of image displacement. An analytical-graphic technique is proposed for matching the angle of view, sensitivity and resolution of such a device, and analytical expressions are given for evaluating these parameters under given conditions of observation. Figures 3, reference 1 Russian.
[164-6610]

PROPAGATION OF SHOCK WAVES THROUGH PLASMA OF GLOW DISCHARGE

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 7, 12 Apr 82 (manuscript received 3 Feb 82) pp 439-443

KLIMOV, A. I., KOBLOV, A. N., MISHIN, G. I., SEROV, Yu. L. and YAVOR, I.P., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] An experimental study of shock waves in the plasma of a glow discharge (degree of air ionization $N_e/N_a \simeq 10^{-6}$-10^{-5}, electron temperature $T_e \simeq 0.5$-2 eV, pressure $p_a = 30$ torr, temperature of neutral component $T_a \leq 1000$ K) has revealed an anomalous increase of their velocity from 500-800 m/s in air to 1200-1300 m/s in the plasma and an appreciable flattening of the wave front from a rise time of 2 μs in air to a rise time of 8-10 μs in the plasma, at the maximum current density of 30 mA/cm^2. These results indicate that a plasma is a strongly dispersing medium for gas dynamic perturbations. According to thermodynamic analysis, such a change cannot be attributed to heating of the gas in a nonuniform temperature field. It is more likely caused by relaxation with attendant release of energy in the vibrational degrees of freedom. The characteristics of shock waves in a plasma are determined by generation of ion-acoustic waves, a higher ionization of excited atoms and molecules, and appearance of an electric double layer at the front of a shock wave. The velocity of shock waves in a plasma depends neither on the direction of the electric field nor on the plasma volume but on their entrance velocity and on the plasma parameters. The authors thank S. A. Bystrov for assisting with the experiment. Figures 2, references 12: 9 Russian, 3 Western. [172-2415]

UDC 533.92

DYNAMICS AND RADIATION OF OPEN (VACUUM) PLASMA-DYNAMIC DISCHARGES OF PLASMA FOCUS TYPE

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82 (manuscript received 25 Feb 80) pp 359-375

KAMRUKOV, A. S., KOZLOV, N. P. and PROTASOV, Yu. S., Moscow Higher Technical School imeni N. E. Bauman

[Abstract] An extensive experimental study was made to determine the space-time structure and the spectrum of radiation from open high-current plasma-dynamic discharges of the plasma focus type under deep vacuum down to 10^{-3} Pa, such discharges being produced in magnetoplasma compressors. Discharges of this kind were produced in vapors of four metals (Cu, Cd, Al, Mo) with C_2F_4 plasma, these metals being used correspondingly for electrodes with thermally stable dielectric (boron carbonitride BNC, zirconium dioxide ZrO_2, or alundum Al_2O_3) spacers. These discharges were produced from a bank of IMM-5-150 low-inductance capacitors. The discharge dynamics and the radiation spectrum were measured covering the range of wavelength from visible to far ultraviolet and the 2-350 eV range of quantum energy. Coefficients of bremsstrahlung and photoionizing absorption were calculated according to the approximate quantum-defect theory. The results suggest several possibilities of controlling the emission spectrum, namely by varying the structure or the chemical composition of the hypersonic stream in the interelectrode space of the MHD compressor. High utilization of the active substance and adequate MHD compression, with necessary high electromagnetic energy density, will ensure attainment of high plasma temperatures and thus also high brightness temperatures in the focus region. The authors thank P. A. Ovchinnikov and A. G. Opekan for assistance in the study. Figures 11, references 56: 50 Russian, 6 Western.
[180-2415]

UDC 537.525

AXIAL COMPRESSION AND SOME ULTIMATE CHARACTERISTICS OF HIGH-VOLTAGE GLOW DISCHARGE

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82 (manuscript received 22 Dec 80) pp 207-214

PUSTYNSKIY, L. N., KHOLEV, S. R. and YAKUSHIN, G. V., Moscow

[Abstract] An extensive experimental study was made of 100-200kV glow discharge axially compressed in cylindrical chambers. Two glass cylinders were

used, both having 10-15 mm thick walls, one 200 mm high with a 90 mm bore and one 300 mm high with a 300 mm bore. Both electrodes were made of stainless steel, the cathode surface specially hardened and smoothed by cold working with a steel ball. Radial current distributions at the anode and the cathode were measured under pressures from 1.8 to 4 Pa. The pressure dependence of maximum voltage and current prior to stability loss was also measured. These characteristics as well as transition from spark to arc discharge were found to depend on gas-tightness, tube surface finish in the cathode region, clearance between cathode and tube wall and charge density gradient in the region of cathode potential drop. The authors thank V. P. Sadov and V. P. Romantsov for active participation in the initial stage of this study. Figures 7, references 11: 6 Russian, 5 Western.
[180-2415]

UDC 537.525

DOMAIN INSTABILITY OF NONSELF-MAINTAINED DISCHARGE IN ELECTRONEGATIVE GASES, PART 1: THEORETICAL ANALYSIS

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 2, Mar-Apr 82 (manuscript received 12 Dec 80) pp 201-206

BARKALOV, A. D. and GLADUSH, G. G., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] The nonlinear stage of adhesive instability of nonself-maintained discharge is analyzed theoretically, on the basis of the domain formation and annihilation mechanism. Moving domains, with a velocity higher than the ion drift velocity, and static domains are considered in the analysis. The differential equations for electric field intensity and positive-ion concentration, with the corresponding dimensionless characteristic equations, are solved in the phase plane, where a closed integral curve describes periodic solutions and where singular points of various kinds depending on the domain velocity can be found. An expression is derived for the domain velocity and estimates are obtained for the thicknesses of leading and trailing domain edges. Figures 3, references 5 Russian.
[180-2415]

UDC 539.292

SUPERCONDUCTIVITY OF METALLIC GALLIUM PHOSPHIDE

Kiev FIZIKA NIZKIKH TEMPERATUR in Russian Vol 7, No 11, Nov 81
(manuscript received 30 Jun 81) pp 1479-1481

TIMOFEYEV, Yu. A., VINOGRADOV, B. V. and YAKOVLEV, Ye. N., Institute of High-Pressure Physics, USSR Academy of Sciences, Troitsk (Moscow oblast)

[Abstract] An experimental study of metallic gallium phosphide has revealed a superconducting transition at the temperature $T_c = 9.3$ K. Measurements were made in a high-pressure chamber of the "rounded cone - plane" configuration, with a thin layer of GaP powder deposited on the plane anvil of VK-6 hard alloy, transition of gallium phosphide from dielectric to metallic state occurring under a mean pressure of 22 GPa. In a low-frequency (20 Hz) magnetic field with an induction of 10^{-2} T amplitude shifted the superconducting transition to lower temperatures twice during one cycle of field alternation, while the resistance of the material varied in phase with the magnetic induction. The authors thank Dr J. Witting for providing research results prior to publication. Figures 2, references 10: 2 Russian, 8 Western.
[167-2415]

THEORETICAL PHYSICS

UDC 517.946:519.46

EXACT QUASI-PERIODIC AND SOLITON SOLUTIONS TO NONLINEAR EQUATIONS OF WAVE PULSE PROPAGATION THROUGH DISSIPATIONLESS TWO-LEVEL MEDIUM

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 4, Apr 82 (manuscript received 5 Feb 81) pp 5-9

BOGOLYUBOV, N. N., Jr, PRIKARPATSKIY, A. K. and SAMOYLENKO, V. G., Mathematical Institute imeni V. A. Steklov; Institute of Mathematics, both of UkSSR Academy of Sciences

[Abstract] The periodic problem for the differential equations of wave pulse propagation through a dissipationless two-level medium

$$\frac{\partial E}{\partial t} + \frac{\partial E}{\partial x} = -2i\rho \quad \frac{\partial n}{\partial t} = i(E\rho^* - E^*\rho) \quad \frac{\partial \rho}{\partial t} = -2inE$$

(E-complex wave amplitude, ρ, n- elements of density matrix $\hat{\rho} = \begin{pmatrix} n & \rho \\ \rho^* & -n \end{pmatrix}$) is solved by methods available for the nonlinear Korteweg-de Vries equation and those available for the nonlinear Schroedinger and Riccati equations. Two linear operators X_λ and T_λ are defined in the space of complex differentiable vector functions

$$X_\lambda = \frac{\partial}{\partial x} + i\lambda\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} + i\begin{pmatrix} 0 & E \\ E^* & 0 \end{pmatrix} + \frac{i}{\lambda}\begin{pmatrix} n & \rho \\ \rho^* & -n \end{pmatrix} \quad T_\lambda = \frac{\partial}{\partial t} - i\lambda\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} - i\begin{pmatrix} 0 & E \\ E^* & 0 \end{pmatrix}$$

(λ- arbitrary complex parameter). Both the density matrix and the complex wave amplitude are assumed to be periodic functions of the space coordinate x. The monodromy matrix $s(x,t,\lambda)$ for the X - operator is introduced that satisfies the equations

$$\frac{\partial S}{\partial x} = [S, Q] \qquad \frac{\partial S}{\partial t} = [S, \Lambda]$$

(matrices Q and Λ equal to the nondifferential parts of operators X_λ and T_λ respectively) and yields two equivalent systems of wave pulse equations. A theorem is stated stipulating under what conditions these systems of equations admit polynomial (in λ) solutions. Solutions to the original equations are

examined subsequently and another theorem is stated stipulating under what conditions it has exact quasi-periodic solutions reducible to quadratures. Article presented by Academician Yu. A. Mitropol'skiy, UkSSR Academy of Sciences. References 10: 7 Russian, 3 Western.
[176-2415]

UDC 531.34

METHOD OF MOMENTS IN PROBLEMS OF DYNAMICS FOR SYSTEMS WITH RANDOMLY VARYING PARAMETERS

Moscow PRIKIADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 46, No 2, Mar-Apr 82 (manuscript received 14 May 81) pp 218-224

DIMENTBERG, M. F., Moscow

[Abstract] Equations of the moment method are derived for linear dynamic systems with randomly varying parameters, assuming that parametric random perturbations in such a system are normal processes of the "white noise" kind uncorrelated to similar external random actions. On this basis a system is analyzed with one degree of freedom

$$\ddot{x} + 2\alpha \dot{x} + \Omega^2 x [1 + \xi(t)] = y(t) = \zeta(t)$$

where $\xi(t)$, $\zeta(t)$ are wideband stationary random processes and α, Ω are constant parameters. In the case of small spectral densities of both random processes as well as a small parameter α it is permissible to change variables, namely $x = A(t)\cos\theta(t)$, $\dot{x} = -\Omega A(t)\sin\theta(t)$, $\theta = \Omega t + \varphi(t)$. A subsequent analysis of the dynamics by the moment method is found to be more extensive than analysis by the perturbation method. The moment method is then applied to a system with two degrees of freedom

$$\ddot{x}_1 + 2\alpha_1 \dot{x}_1 + \Omega_1^2 x_1 = \lambda_{12} x_2 \xi(t) + \zeta_1(t)$$

$$\ddot{x}_2 + 2\alpha_2 \dot{x}_2 + \Omega_2^2 x_2 = \lambda_{21} x_1 \xi(t) + \zeta_2(t)$$

where $\xi(t)$, $\zeta_i(t)$ are centered wideband stationary random processes. The method is also extendable to systems with correlated internal and external random perturbations. The author thanks V. B. Kolmanovskiy for discussing this study. References 10: 9 Russian, 1 Western.
[179-2415]

MATHEMATICS

UDC 512.624

NUMBER OF CLASSES OF PROJECTIVELY EQUIVALENT BINARY FORMS OVER FINITE FIELD

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNICHESKIYE NAUKI in Russian No 4, Apr 82 (manuscript received 16 Jul 81) pp 9-12

VISHNEVETSKIY, A. L., Khar'kov Military Air Force College of Communications

[Abstract] A second-degree projective group $G = PGL(2,q)$ is given over a finite field F of q elements. Its elements are 2x2 matrices over F, treated with an accuracy down to an arbitrary multiplier among $F\setminus\{0\}$ and F_n [x,y] is a set of nth-degree binary forms over F treated with an accuracy down to some multiplier among $F\setminus\{0\}$. Nine theorems are stated pertaining to numbers of H-, G-, H_0- orbits of the F_n [x,y] set, number of H_0-orbits of the F_n[x] set number of H_0- orbits of the set of nth-degree polynomials irreducible over F, numbers of H_0-, G- orbits of the F_n' [x] set of nth-degree polynomials over F without roots in F, number of G- orbits of the F_n' [x,y] set, number of G-orbits of the set of nth-degree forms irreducible over F, and number of nth-degree nonisoclinic P groups. Another theorem is stated pertaining to numbers of nonequivalent Goppa codes. Article presented by Academician Yu. A. Mitropol'skiy, UkSSR Academy of Sciences. References 7: 4 Russian, 3 Western. [176-2415]

UDC 518.90

NORMAL FORM OF POSITIONAL GAMES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 264, No 1, May 82 (manuscript received 13 Nov 81) pp 30-33

GURVICH, V. A., Institute of Terrestrial Physics imeni O. Yu. Schmidt, USSR Academy of Sciences

[Abstract] The simplest model of a positional game, namely a tree with branches and vertices including the top, is considered for the purpose of constructing

the matrix of its normal form. The theorem that such a matrix must be stable and rectangular is subsequently applied to two-color graphs and nonrepeatable Boolean functions with corresponding strategies. Article presented by Academician L. V. Kantorovich 13 October 1981. Figures 3, references: 4 Russian.
[170-2415]

UDC 517.946+532.135

ANALYSIS OF SOLUTIONS TO DIFFERENTIAL EQUATION NOT RESOLVABLE WITH RESPECT TO DERIVATIVE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 264, No 1, May 82 (manuscript received 4 Nov 81) pp 11-13

AKHMEROV, R. R. and NOVIKOV, V. A.

[Abstract] The second-order ordinary differential equation not resolvable with respect to the derivative $\frac{d}{dx}\left[\nu\left(\frac{du}{dx}\right)\frac{du}{dx}\right]=u\frac{du}{dx}$, $x\in[0,X]$, $u(0)=a$, $u(X)=b$ is the steady-state version of the N. N. Yanenko equation describing intricate flow of viscous fluids, $u: [0,X]\to R$ being an unknown function and $\nu: R\to R$ being a fixed alternating asymptotically positive smooth function having the form of a second-degree polynomial with positive coefficients. This equation is solved for a set of two boundary conditions, at $x = 0$ and at $x = X$, through integration and subsequent reduction to the corresponding first-order Cauchy problem also not resolvable with respect to the derivative. Four classes of solutions are defined on the basis of continuity and differentiability of the function $u: [0,X]$. Solutions to the original differential equations are then extended to include an n-th class and symmetrized fourth-class ones. Six theorems are stated pertaining to the existence and the number of solutions in each class. Article presented by Academician N. N. Yanenko 27 October 1981. References 3 Russian.
[170-2415]

UDC 62-50

OBSERVATION OF LINEAR OBJECT

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 46, No 2, Mar-Apr 82 (manuscript received 24 Jan 81) pp 212-217

PSHENICHNYY, B. N. and POKOTILO, V. G., Kiev

[Abstract] The problem of observing an object on the basis of signals $y_t = \phi_t z + w_t$ ($t \in T$, $z \in R^n$, z- unknown vector of parameters, ϕ_t-determinate mxn matrices, w_t-stationary in-narrow-sense random process) is considered when random perturbations occur in the measuring channel. A few constraints on the system and on the w_t- process are stipulated, this process assumed to be a regular one with weak mixing. Two theorems are stated and proved pertaining to estimates $z_1(\psi, N)$ of the scalar quantity ψz ($\psi \in R^n, \|\psi\| = 1$, N- number of readings). The consequences of these theorems are applied to a linear dynamic system $\frac{dx}{dt} = Ax$ ($t \geq 0$) and vectors $y_k = Bn(t_k) + W_k$ read at discrete intervals of time. An additional lemma is proved and illustrated on two examples with matrices A and B: $A = \begin{Vmatrix} 0 & 1 \\ 0 & 0 \end{Vmatrix}$, $B = \|1, 0\|$; $A = \begin{Vmatrix} 0 & 0 \\ -\omega^2 & -2\delta \end{Vmatrix}$, $B = \|1, 0\|$. References 4 Russian.
[179-2415]

UDC 62-50

PROPERTIES OF POTENTIAL IN DIFFERENTIAL GAME

Moscow PRIKLADNAYA MATEMATIKA I MEKHANIKA in Russian Vol 46, No 2, Mar-Apr 82 (manuscript received 16 Jun 81) pp 204-211

SUBBOTIN, A. I. and SUBBOTINA, N. N., Sverdlovsk

[Abstract] A positional differential two-player game with fixed termination time is considered, of particular interest being necessary and sufficient conditions which the potential (value function) in such a game must satisfy to ensure stability. Three theorems are stated and proved, with the aid of three lemmas, pertaining to these conditions. The first applies to a continuous potential, the other two apply to the class Lip (Lipschitz condition) of value functions differentiable with respect to directions. Such functions include piecewise-smooth ones and functions regular up to some boundary. A fourth theorem, a corollary of the third, extends the latter for Lip $\cap$ Dif value functions to the problem of optimal programmable control (minimization of a functional). References 15: 11 Russian, 4 Western.
[179-2415]

OPTIMALITY PRINCIPLES IN COOPERATIVE DIFFERENTIAL GAMES WITH NONTRANSFERRABLE PAYOFFS

Budapest PROBLEMY UPRAVLENIYA I TEORII INFORMATSII in Russian Vol 11, No 1, Jan-Feb 82 (manuscript received 10 May 81) pp 29-39

DANILOV, N. N., Kemerovo State University

[Abstract] The author considers cooperative differential games with nontransferrable payoffs as a characteristic set with optimality defined in the sense of stability. This idea was first considered by L. A. Petrosyan [see "Stability of Solutions in Differential Games With Many Participants", VESTNIK LENINGRADSKOGO UNIVERSITETA, No 19, 1977]. Here Petrosyan's approach is extended to a wider glass of games, and conditions of existence of some stable solutions of such games are established. Using the properties of the proposed characteristic set, an alternative theorem is proved with reference to the initial capabilities of the players, asserting that either only one player can achieve positive results by forced actions, or a coalition can prevent any player from favorable action. The problem of stability of solutions is studied in a nonantagonistic differential game treated as a cooperative game with nontransferrable payoffs. Stability conditions are found for $\mathfrak{M}_i^{(i)}$-stable configurations, and a constructive method is given for producing such a set. References 4 Russian.
[175-6610]

CONFERENCE ON PARTIAL DIFFERENTIAL EQUATIONS

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 37, No 2(224), Mar-Apr 82 pp 263-268

SKRYPNIK, I. V., DANILYUK, I. I., MARKOVSKIY, A. I. and MEL'NIK, Z. O.

[Abstract] The second conference on partial differential equations was held by the Institute of Applied Mathematics and Mechanics (UkSSR Academy of Sciences) on 18-20 September 1981 at the "Latoritsa" sports and health resort, in memory of Yaroslav Borisovich Lopatinskiy (deceased on 10 March 1981). Participating in the conference were 159 mathematicians from 29 Soviet cities, among them 32 with degrees of doctor and 67 with degrees of candidate. Part of the conference was devoted to Lopatinskiy's work and contributions in the field of boundary-value problems. Other topics included behavior of solutions to systems of equations of theory of elasticity at infinity, global solvability of Cauchy problem, attractors of nonlinear parabolic equations, Lie algebras and superalgebras. Brief presentations were made on self-coupling of

differential operators and evolutionary equations, perturbations of nonlinear Fredholm operators, bifurcation of waves describable by parabolic equations, nonlinear differential equations of integral geometry, linear elliptic equations with degeneration into general boundary-value problems, trigonometric series in mathematical physics, quasi-stationary Stefan problem, wave equation in Riemann space, Green matrix of parabolic boundary-value problems with increasing coefficients, continuity of solutions to elliptic equations, generalized solutions to Cauchy problem for Burgers and Korteweg-de Vries equations, behavior of solutions to quasilinear elliptic equations in unbounded regions, nonstandard analysis, approximation of solenoidal and potential vector fields, linear degenerating parabolic boundary-value problems, Fragman-Lindeloef principle, coupling of solutions to second-order partial differential equations in a plane, $(s, \emptyset)$-volume and its use for solving second-order elliptic equations, special boundary-value problems, solvability of general elliptic boundary-value problems with a parameter in L_p-spaces of generalized functions, theory of branching continuous fractions and its use for solving differential equations, nonlinear elliptic boundary-value problems in regions with fine-grain boundary, new method of analyzing degenerate hyperbolic equations, nonlinear boundary-value problems for minimum-surface equations, backscattering problem for electric signals, spectral problem for Laplace operator in fundamental regions of finite groups of reflections by special Riemann manifolds, mathematical theory of stochastic automata and use of partial differential equations, and mixed problem for equations well-conditioned according to I. G. Petrovskiy. The transactions will be published. The next conference will take place in 1983 in Donetsk.
[177-2415]

COHOMOLOGS OF CERTAIN LIE ALGEBRAS AND SUPERALGEBRAS OF VECTOR FIELDS

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 37, No 2(224), Mar-Apr 82 (manuscript received 7 May 81) pp 233-234

RETAKH, V. S., Central Scientific Research and Experimental Design Institute of Industrial Buildings and Structures, and FEYGIN, B. L., Institute of Solid-State Physics

[Abstract] A new method is proposed for calculating the cohomologs of nullpotent subalgebras of Lie superalgebras of vector fields in an (n,k)-dimensional space. The method is based on five theorems pertaining to one family $L_1(t)$ of Lie algebras and two families $N_1(t)$, $N_2(t)$ of Lie superalgebras. These theorems establish the properties of cohomologs, namely the manner of their generation and continuation, as well as the conditions of triviality of spaces of generating algebras and the relation between them. The authors thank D. A. Deytes and D. B. Fuks for assistance. References 4: 3 Russian, 1 Western.
[177-2415]

BOUNDED AND QUASI-PERIODIC SOLUTIONS TO CERTAIN NONLINEAR EVOLUTIONARY EQUATIONS

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 37, No 2(224), Mar-Apr 82
(manuscript received 13 May 81) pp 223-224

PANKOV, A. A., Institute of Application Problems in Mechanics and Mathematics

[Abstract] A theorem is proved establishing the existence of solutions to the equation $\frac{du}{dt} + L(t)u + A(t,u) = f(t)$, also the conditions under which such a solution will be unique and independent of time t. Quasi-periodicity of this equation according to Bezikovich and its solvability in Stepanov spaces are also dealt with. The results can be applied to other equations such as a symmetric hyperbolic one and a nonlinear one of the Schroedinger kind. References 4 Russian.
[177-2415]

ASYMPTOTIC EXPRESSIONS FOR SOLUTION OF SYSTEM OF NONLINEAR SCHROEDINGER EQUATIONS

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 37, No 2(224), Mar-Apr 82
(manuscript received 10 Aug 81) pp 215-216

NOVOKSHENOV, V. Yu., Department of Physics and Mathematics, Bashkir branch, USSR Academy of Sciences

[Abstract] The "vector" nonlinear Schroedinger equation $i\frac{\partial u_n}{\partial t} + \frac{1}{2}\frac{\partial^2 u_n}{\partial x^2} + u_n \sum_{k=1}^{N} |u_k|^2 = 0$ $(n = 1,2,\ldots,N)$ with the initial condition $u_n(x,0) = u_n^0(x)$ $u_n^0 \in L_1$ is considered, this equation appearing in the theory of two-dimensional self-focusing of electromagnetic waves with polarization. The soliton-free asymptotic behavior at $t \to \infty$ of the solution to the corresponding Cauchy problem in class L_1 is established on the basis of a theorem involving certain properties of the scattering matrix. The problem of determining the asymptotic behavior here is more difficult than for the scalar nonlinear Schroedinger equation, inasmuch as solution of the scattering equations must be extended from $-\infty$ to any λ in the upper half-space. References 5 Russian.
[177-2415]

LOWER LIMIT OF MEAN VOLUME OF SEQUENTIALLY CONTROLLABLE SAMPLE

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 37, No 2(224), Mar-Apr 82
(manuscript received 14 Oct 81) pp 209-210

MALYUTOV, M. B., Moscow State University

[Abstract] For sequential design of experiments the identity and the lower limit according to A. Wald are extended to an arbitrary sequential plan. With the aid of three lemmas, a theorem is proved pertaining to deficiency of a weaker estimate. Another theorem is proved pertaining to class A of strategies with all probabilities given, whereupon the estimate in this case is compared with the Hefding estimate. References 4: 3 Russian, 1 Western.
[177-2415]

COHOMOLOGS OF gl (n) ALGEBRA IN CASE OF FINITE CHARACTERISTIC

Moscow USPEKHI MATEMATICHESKIKH NAUK in Russian Vol 37, No 2(224), Mar-Apr 82
(manuscript received 1 Sep 81) pp 199-200

KOZERENKO, K. V., Institute of Control Problems, USSR Academy of Sciences

[Abstract] Cohomologs of the complete gl (n) matrix algebra with trivial coefficients are established for the case of a finite-characteristic rather than zero-characteristic field. New tensor invariants appear when the tensor rank is equal to the product of field characteristic by the matrix order. Cohomologs of this algebra are shown to differ from the classical ones already when n- 1 is equal to the field characteristic. This is demonstrated by multigraduation in $C^*(gl(n,F))$ for the two cases $(r_1,\dots,r_n) \neq (0,\dots,0)$ and $(r_1,\dots,r_n) = (0,\dots 0)$. An appropriate theorem is stated and proved for each case. The author thanks D. B. Fuks for formulating the problem and guidance, also B. L. Feygin for helpful suggestions. References 4 Russian.
[177-2415]

UDC 517.98

FOURIER SERIES OF PERIODIC ULTRADISTRIBUTIONS

Kiev UKRAINSKIY MATEMATICHESKIY ZHURNAL in Russian Vol 34, No 2, Mar-Apr 82
(manuscript received 22 Jun 80) pp 144-150

GORBACHUK, V. I., Institute of Mathematics, UkSSR Academy of Sciences

[Abstract] Generalized periodic functions of the ultradistribution type of class $D'\{m_k\}$ or $D'(m_k)$ are represented by Fourier series, and such series are summed by the Abel-Poisson method. It is shown that all classes of generalized periodic functions are embedded in the space of formal trigonometric series, and are completely described by the behavior of the coefficients or partial sums of their Fourier series. The author also establishes localization of abelian transformation of ultradistributions of the given classes. References 4 Russian.
[161-6610]

UDC 519.21

SUPERPOSITION OF TWO DEPENDENT MARKOVIAN RECONSTRUCTION PROCESSES

Kiev UKRAINSKIY MATEMATICHESKIY ZHURNAL in Russian Vol 34, No 2, Mar-Apr 82
(manuscript received 17 Sep 80) pp 171-176

KONOVALYUK, V. S., Kiev State University

[Abstract] The author generalizes the results of a previous article [Konovalyuk, V. S., "Two-Channel System With Dependent Failures", KIBERNETIKA, No 6, 1981, pp 81-87], where the steady-state distribution of two dependent reconstruction processes was found. The same method of proof of the theorem is used. In this paper, steady-state distribution of the superposition of two dependent markovian reconstruction processes is found, where superposition is understood to mean the process in which transition from state to state takes place at the instants of change in the states of the superposed processes, and dependence means that there is a certain probability of a change in state of one of the processes at the instant of transition from state to state of the other process. References 3 Russian.
[161-6610]

UDC 621.3.078

SYNTHESIZING REFERENCE MODE FOR CONTROL SYSTEMS UNDER CONDITIONS OF UNCERTAINTY

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 25, No 3, Mar 82 (manuscript received 21 Apr 81) pp 25-28

KOVAL'SKIY, V. S., Moscow Higher Technical Academy imeni N. E. Bauman

[Abstract] In solving some control problems it is important to account for different kinds of uncertainties because of the absence of reliable information on perturbations and their statistical characteristics and because of stringent requirements on reliability of attainment of the terminal state. Under these conditions, definition of a reference mode is an important stage in synthesizing control systems. In this paper the author suggests a possible approach to solution of the problem of transferring the state of an object described by a system of ordinary differential equations into a predetermined region of states under conditions of uncertainty. The optimum reference mode is determined that minimizes the risk of attaining the goal. The suggested approach reduces calculation of the reference mode to solution of a Cauchy problem. The idea behind calculation of the reference mode is that the given terminal state is transported in reverse time in such a way that when motion is in forward time the control system has maximum guaranteed reserves of control at every instant. Figure 1, reference 1 Russian.
[164-6610]

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USSR REPORT

PHYSICS AND MATHEMATICS

No. 80

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SUPERSONIC DYNAMICS OF DOMAIN WALLS IN YTTRIUM ORTHOFERRITE

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIXIKI in Russian Vol 35, No 9, 5 May 82 (manuscript received 23 Mar 82) pp 373-375

CHETKIN, M. V., GADETSKIY, S. N. and AKHUTKINA, A. I., Moscow State University imeni M. V. Lomonosov

[Abstract] A study was made of the dynamics of domain walls in $YFeO_3$ at supersonic velocities. At such velocities the displacement of domain walls ceases to be one-dimensional, especially at a temperature near 100 K corresponding to maximum mobility. Tests were performed with 100 μm thick specimens cut perpendicularly to the optical axis. Light pulses of 6 ns duration for high-speed photography were obtained from oxazine dye pumped by an LGI-21 laser. Measurements in a magnetic field indicate that at magnetic field intensities above 60 Oe the displacement at velocities above 4000 m/s becomes two-dimensional. As the mobility of domain walls reaches 20,000 cm/(s·Oe), moreover, their motion becomes distinctly nonsteady. This evidence calls for refinement of the theory of domain wall and acoustic wave interaction, which so far has considered only one-dimensional motion of domain walls. Figures 3, references 7 Russian. [185-2415]

DETECTION OF LONG-WAVE INFRARED RADIATION EMISSION BY HOT HOLES IN GERMANIUM IN CROSSED ELECTRIC AND MAGNETIC FIELDS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 35, No 9, 5 May 82 (manuscript received 1 Mar 82) pp 360-362

VOROB'YEV, L. Ye., OSOKIN, F. I., STAFEYEV, V. I. and TULUPENKO, V. N., Leningrad Polytechnic Institute imeni M. I. Kalinin

[Abstract] It has been demonstrated experimentally that strong scattering of hot holes by optical phonons in p-Ge in crossed electric and magnetic fields at low temperatures causes inversion of the distribution function of light holes relative to that of heavy holes, which makes possible emission and amplification of long-wave infrared radiation. A specimen of p-Ge with impurity concentration n_p $10^{15}cm^{-3}$ was placed in an optical resonator formed by two mirrors with a reflection coefficient of 100% and 96-98% (exit mirror) respectively. A 50 μm

wide vacuum gap served as selector of longitudinal modes at wavelengths not shorter than 100 μm. Radiation emission at 10 and 80 K temperatures was detected by a Ge <Ga> photoreceiver at 4.2 K with a set of filters (quartz, Teflon, black polyethylene). Spontaneous emission, occurring without a resonator, was not detected. The dependence of intensity of stimulated emission on both electric field intensity and magnetic field intensity was found to be characterized by a threshold corresponding to inversion of the hole distribution function, after which impurity scattering independent of the temperature becomes the principal mechanism. Reflection losses exceed by far diffraction losses at mirrors, and at relatively low hole concentrations it is easily possible to satisfy the conditions for emission of longer-wave ($\lambda > 200$ μm) radiation. The authors thank I. B. Levinson for helpful comments. Figures 3, references 9: 7 Russian, 2 Western.
[185-2415]

CONVERSION AND MULTIPLICATION OF SIGNAL FREQUENCY IN ACOUSTIC-INJECTION TRANSISTOR

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 4, Apr 82
(manuscript received 23 Jun 81) pp 793-794

GULYAYEV, Yu. V., MANSFEL'D, G. D. and ORLOVA, G. A., Institutes of Radio Engineering and Electronics, USSR Academy of Sciences, Moscow

[Abstract] A new acoustoelectronic device, an acoustic-injection transistor, is considered for frequency conversion and multiplication. The operation of this device rests on the principle that the impedance of a semiconductor connected in series with a voltage source (frequency f_V) and load resistor is made to oscillate at the frequency of volume or surface acoustic waves (f_A) by the electron bunches accompanying these waves. The two frequencies add and subtract in the load current, in which two corresponding components can be detected. The feasibility of frequency conversion by means of such a device has been demonstrated theoretically on the basis of the relation between output and input voltages, also experimentally with an electroacoustic transducer exciting surface acoustic waves at 83.4 MHz in a Y-cut $LiNbO_3$ crystal on whose surface has been deposited a 2 μm thick photosensitive CdS film containing resistive interdigital transducer contact tabs and having a resonance frequency of 28 MHz. The voltage generator was tuned to the same frequency 28 MHz. Signals appeared across a 30 ohm load at frequencies 111.4 MHz (f_A+f_V), 56 MHz (f_r+f_V), and 55.4 MHz (f_A-f_V). A surface acoustic wave at frequency $f_r = 28$ MHz was generated by a periodic array of contact tabs, acting as an electroacoustic transducer shunted by the semiconductor film. The authors thank I. M. Kotelyanskiy, V. I. Krikunov and Ye. N. Mirgorodskaya for preparing the specimens, also S. V. Boritko for assisting with the measurements. Figures 2, references 3 Russian.
[186-2415]

UDC 539.23

STRUCTURAL ANOMALIES IN THIN COLUMBIUM AND TUNGSTEN FILMS PRODUCED IN DISCHARGE WITH OSCILLATING ELECTRONS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 4, Apr 82 (manuscript received 4 Oct 80, after final revision 15 Jan 81) pp 765-768

KONONKOVA, N. N., REYKHRUDEL', E. M. and SMIRNITSKAYA, G. V., Moscow State University imeni M. V. Lomonosov

[Abstract] An experimental study was made of tungsten and columbium films produced by sputtering in a discharge with oscillating electrons. This method can yield high-quality films, inasmuch as they build up under low gas pressure with continuous electron or ion bombardment of both film and substrate. Polycrystalline bulk specimens were used as feed material, with an impurity content of 0.013% C + 0.02% O in the tungsten cathode and 10^{-5}% total in the columbium cathode. Auger spectroscopy revealed the same impurity content in the films, with maximum concentration at the surface. Electron and x-ray diffraction analysis revealed a quasi-amorphous structure in tungsten films less than 100 Å thick and in columbium films less than 200 Å thick. Thicker films contained, in addition to their normal b.c.c. α-phase, also their anomalous c.p.h. β-phase as well as respective oxide (WO_3, CbO_2) and carbide (W_2C, Cb_2C). Thicker films of both elements were found to have a fine-grain structure (50-150 Å), regardless of the conditions of film deposition, the grains being larger and increasing with film thickness in columbium. Up to 10,000 Å crystallites of the pure element or its oxide formed in the fine-grain structure of thicker tungsten films bombarded by electrons at a positive bias voltage (330 V) and in columbium films bombarded with electrons at a zero bias voltage (much lower electron flux intensity). Figures 4, references 5: 3 Russian, 2 Western. [186-2415]

ELECTROACOUSTIC STORAGE OF SURFACE ACOUSTIC WAVES IN SYSTEM THAT INCLUDES $LiNbO_3$ AND EFFICIENT SECONDARY EMITTER FILM

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 10, 26 May 82 (manuscript received 16 Feb 82) pp 604-607

VOROSHEN', V. I. and CHIRKIN, N. M., Minsk Radio Engineering Institute

[Abstract] Electroacoustic storage is based on nonuniform redistribution of low-energy secondary electrons in piezoelectric fields of surface acoustic waves, and the current density of these secondary electrons determines the amplitude of output signals and the frequency band of the storage. The parameters can be improved by increasing the coefficient of secondary electron emission of the crystal's surface. The results are given of an experimental study of electroacoustic storage of surface acoustic waves in $LiNbO_3$ YZ-cut crystals with films of an efficient secondary emitter, viz., magnesium fluoride. The MgF_2 film

was deposited layer by layer onto a 60 X 10 X 2 mm crystal placed in a vacuum chamber on a turntable at whose three fixed positions ion plasma cleaning, resistive vaporization and subjection to an electron gun, respectively, were performed. A quartz sensor served the purpose of monitoring the thickness of the film as it was sprayed. Surface acoustic waves were exicted by means of interdigital transducers with split electrodes effectively operating at the first and third harmonics. Measurements were made simultaneously at two frequencies, 30 and 90 MHz, with identical configuration of crystal and gun and identical thicknesses of the deposited layer. Experimental curves are presented, illustrating the dependence of the amplitude of the reproduced signal on the total charge density of the record and reproduce electron beam. Seven experiments were conducted with MgF_2 films measuring 3, 8, 18, 52, 100, 260 and 500 nm thick. Curves are also presented for the crystal before deposition of the film. The experimental results demonstrate that it is not advisable to use films with the thickness of the sprayed film, h, much greater than the depth, $_s$, for the discharge of secondary electrons from MgF_2 with specific energy of the primary beam. The optimum value of h for the frequency range of 30 to 90 MHz for MgF_2 is in the range of 20 to 50 nm. By depositing a film of efficient secondary emitter it is possible to increase approximately threefold the operating frequency of an electroacoustic storage. Figure 1, references 5: 4 Russian, 1 Western. [198-8831]

UDC 537.533.335

FOCUSING OF FINE PARTICLES BY MEANS OF PLANE MAGNETIC FIELDS

Leningrad ZHURNAL TAKHNICHESKOY FIZIKI in Russian Vol 52, No 4, Apr 82
(manuscript received 27 Apr 81) pp 729-734

SHTEPA, N. I., Chernigov Pedagogical Institute imeni T. G. Shevchenko

[Abstract] The feasibility of focusing and transforming beams of fine (10^{-1} - 10^{-4} cm) spherical magnetic particles in vacuum or in fluids (gas, liquid) by means of a constant plane magnetic field with planar symmetry is established on the basis of theoretical analysis of particle ballistics. A second-order homogeneous ordinary differential equation describing the trajectory of a particle in such a field is obtained, assuming that the magnetic field is quasi-uniform in the vicinity of a particle, that the flow of the fluid obeys Stokes' law, and that interaction between particles as well as any fluctuation effects are negligible. Calculations are continued for the two extreme cases of a magnetization vector: consisting only of the constant residual component independent of the magnetic field intensity, and consisting only of the induced component proportional to the magnetic field intensity or being equal to zero. Focusing and transformation of a particle beam moving parallel to the axis near the plane of symmetry of the magnetic field in a stream of fluid flowing at constant velocity is considered using a weak thin cylindrical magnetic lens. It is found that the beam shaping process can be controlled, within some range, by varying the magnetic field intensity and the stream velocity. A beam of ferromagnetic or paramagnetic particles expands, while a beam of diamagnetic particles contracts. Calculations for carbon steel, quartz, and ebonite particles in an air stream indicate that a weak magnetic lens is effective only for ferromagnetic particles. References 5 Russian.
[186-2415]

CONTROL OF TIME AND SPACE STRUCTURE OF HIGH-CURRENT ELECTRON BEAM

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 10, 26 May 82 (manuscript received 11 Mar 82) pp 614-616

AYRAPETOV, A. Sh. and KRASTELEV, Ye. G., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] It is necessary to control the time and space characteristics of high-current electron beams in solving many problems associated with their use. A demonstration is given of the possibility of controlling these parameters on account of interaction of the beam's electrons with a specially formed reverse-current magnetic field, using as an example devices for modulating the beam's current and controlling the form of its cross section, respectively. Devices implementing both methods employ vacuum transport channels with dielectric walls so that the high-current electron beam is propagated without external confining fields and conditions are absent for the flow of reverse current in the space of the channel. The device implementing the current modulation method consists of a segment of a dielectric tube placed behind the anode grid of the electron gun, an electron collector, and a reverse-current conductor situated at one end of the channel and connecting the collector with the grounded anode grid. The beam injected into the channel is propagated along it until the electrons strike the collector, after which part of the reverse current begins to flow through the metal conductor. Under the influence of the magnetic field of this current the electrons are deflected from the axis and strike the channel's wall and the reverse current circuit is closed through the plasma near the wall. The force acting on the electrons changes sign and the beam returns to its original position and the cycle is repeated, resulting in transverse oscillations of the beam which in turn result in modulation of the current of electrons exiting from the opening in the collector. Oscillograms are presented for the beam current with electron energy of approximately 500 keV for a modulator with a cylindrical channel 34 mm in diameter and a conical channel with an exit opening 17 mm in diameter. Current modulation cycles of approximately 6 ns and 3 ns, respectively, were achieved. The respective percentage modulations were approximately 30 percent and approximately 100 percent. The form of the cross section of a high-current electron beam can be controlled without deflection of the beam from the channel's axis by means of a similar device in which the electron collector is connected to the electron gun's anode by means of several symmetrically arranged wires. The configuration of the reverse current's magnetic field is then equivalent to the field of a multipole magnet with a number of poles twice that of the number of wires. Camera obscura measurements were made of electron bremsstrahlung using a tantalum target 0.4 mm thick, with channel diameter of 51 mm, channel length of 100 mm, beam current of approximately 10 kA and electron energy of approximately 500-kV. Figures 2, references 2 Russian.
[198-8831]

UDC 533.6.011.72

SELF-ADJOINT SHOCK WAVE WITH STRONG EMISSION OF RADIATION

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 264, No 2, May 82
(manuscript received 25 Jan 82) pp 338-341

KALININ, A. V. and STEPANOV, A. Ye., Institute of High Temperatures, USSR
Academy of Sciences, Moscow

[Abstract] The dynamics of a shock wave propagating through rarefied gas can, under certain conditions, be affected by radiation emission by the gas occurring not only behind the wave front. In the case of a shock wave generated by expansion of a hot laser plasma its dynamics will be affected in that the radiative cooling of the gas behind the front becomes comparable with the work of expansion. The self-adjoint equations describing the behavior of plane, cylindrical, and spherical shock waves with one-dimensional flow can be reduced to a Cauchy problem at the steady-state limit with appropriate boundary conditions. This problem has been solved numerically for density, pressure, and temperature distributions behind the wave front, assuming a zero radial pressure gradient. This assumption is not valid, however, inasmuch as the solution violates the law of mass conservation behind the wave front, where almost the entire gas mass concentrates inside a thin shell. References 9: 7 Russian, 2 Western.

[190-2415]

DYNAMICS OF IONIZING SHOCK WAVES DURING ADIABATIC GAS FLOW

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 82, No 4, Apr 82 (manuscript received 8 Jun 81) pp 1104-1113

ZOREV, N. N., SKLIZKOV, G. V. and SHIKANOV, A. S., Institute of Physics imeni
P. N. Lebedev, USSR Academy of Sciences

[Abstract] In an experimental study of strong ionizing shock waves generated by laser beams, "free" propagation of such shock waves was tracked with "Kal'mar" 9-channel equipment and by superhigh-speed schlieren photography under conditions of adiabatic flow of deuterium gas at 1.5-20 torr pressures.

Targets in the stream, solid and hollow glass spheres 70-250 μm in diameter, were heated by a high-power light pulse, to form a plasmatic corona with a dropping density profile and expanding into the ambient space at velocities of 10^7-10^8 cm/s. The results are evaluated theoretically in terms of the solution to the corresponding equation of motion with spherical symmetry, based on energy balance under conditions of both ionization and dissociation. It is found that the radius-time diagram depends on the total energy in the wave as well as on density, velocity and pressure distributions behind the wave front, rather than on changes in the adiabatic exponent. A correlation between theory and experiment is established on this basis and, with the error of wave radius determination reduced to minimum, the maximum error of wave energy determination is estimated at 8%. The authors thank I. V. Nemchinov and V. B. Rozanov for helpful comments. Figures 3, table 1, references 26: 16 Russian, 10 Western.
[181-2415]

ELECTRONIC RELAXATION MECHANISM BEHIND POWERFUL SHOCK WAVE FRONT

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 9, 12 May 82 (manuscript received 30 Nov 81) pp 523-527

PROSTNEV, A. S. and YUSHCHENKOVA, N. I., Institute of Chemical Physics, USSR Academy of Sciences, Moscow

[Abstract] An intense exothermic stage exists in relaxation behind the front of a shock wave; nonmonotonic distributions of parameters behind the front and curving and breakdown of the front are associated with this. In inert gases this stage is represented by dissociative recombination of molecular ions, superequilibrium concentrations of which form near the shock wave front in reactions with metastable particles. A demonstration is given here of the possibility of nonmonotonic distribution of parameters in the reaction zone caused by processes of generation of metastable particles in combination with the reactions metntoned. The relaxation zone behind the shock wave is characterized by high translational temperatures of heavy particles, T, and relatively low temperatures of electrons, T_e. Processes of collision of heavy particles result in an increase in the internal energy of the system, electrons colliding with excited atoms tap this energy and the system tends toward a certain quasi-steady state caused by temperature nonequilibrium. In the region where $T_e < T$, the electronic relaxation mechanism includes groups of the following elementary processes: origin of active particles; formation of particles with high reactivity and high internal energy content; collision activation and deactivation of particles with different internal energies; processes of conversion of internal energy into kinetic energy; process of generation (avalanche formation) of metastable particles; and processes of destruction of active particles. The mechanism is formulated for a model of energy states of atoms including atoms of argon in the ground, metastable and excited states. The existence of the process of avalanche formation of metastable particles is a distinctive feature of the kinetic scheme, and the role of this process grows with an increase in the energy of the shock wave. Deactivation of metastable particles takes

place in collision with electrons and because of the low value of T_e transitions of metastable atoms into the ground state and population of A* levels are the most effective, since the activation energy is now high. A quasi-steady relationship is established between concentrations of charged particles, n*, and electrons, n_e, since the time for the establishment of quasi-steady values of n* is much shorter than the relaxation time. Curves are shown, illustrating the dependence on the Mach number of the frequency of oscillations of electron concentration and its ratio to the damping factor in the relaxation zone behind a shock wave in argon with various kinetic constants. With low Mach numbers oscillations do not originate because of the low rate of formation of metastable particles, and with very high Mach numbers oscillations are damped rapidly. Figure 1, references 6: 5 Russian, 1 Western.
[197-8831]

LASERS AND MASERS

UDC 535.37

CATHODOLUMINESCENCE OF CERTAIN SEMICONDUCTORS AND DEVELOPMENT OF LASER WITH ELECTRON-BEAM PUMPING

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 36, No 5, May 82 (manuscript received 21 Sep 81) pp 738-745

KURBATOV, L. N., DIROCHKA, A. I. and KOZINA, G. S.

[Abstract] Studies made pertaining to the mechanism and the spectrum of impurity-band cathodoluminescence of GaAs, polycrystalline A^2B^6 and laminar A^3B^6, also ternary semiconductor compounds are reviewed from the standpoint of their impact on subsequent development of lasers with electron-beam pumping. Foremost among these materials are lead-tin chalcogenides and $GaSe_xTe_{1-x}$ solid solutions, monoclinic ($0 \leq x \leq 0.35$) or hexagonal ($0.6 \leq x \leq 1$). The spectrum covered so far includes ultraviolet 0.3-0.4 μm (ZnS, ZnO, $Ga_xAl_{1-x}N$), visible 0.4-0.7 μm (CdSe, CdSSE), near infrared 0.7-0.9 μm ($GaAs_{1-x}P_x$, $0 \leq x \leq 0.41$), near infrared 0.9-2.0 μm (InGaAs, GaAsSb, InGaAsP/InP, InGaAsSb/GaSb). Promising are InAsSb on $InAs_xSb_yP_{1-x-y}$ interlayer for intermediate infrared 3-5 μm and $Pb_{1-x}Sn_xTe$ ($0.05 \leq x \leq 0.2$) for intermediate infrared 8-14 μm. A further development will be materials for smooth wavelength regulation. Figures 4, references 22: 16 Russian, 6 Western.
[192-2415]

UDC 621.378.3

STABILIZED GAS-DISCHARGE LASER WITH EXTERNAL ABSORPTION CELL IN GAIN MODULATION MODE

Minsk ZHURNAL PRIKLADNOY SPEKTROSKOPII in Russian Vol 36, No 5, May 82 (manuscript received 6 May 81) pp 722-727

MIRONOV, A. V. and PRIVALOV, V. Ye.

[Abstract] The effect of gain modulation on the frequency stability of a laser is examined in the case of frequency stabilization by means of an absorption cell. The radiation intensity is assumed to be modulated harmonically, through

modulation of the discharge current in the active medium, while simultaneously the radiation frequency is modulated by a harmonic signal and by a frequency deviation signal. An external absorption cell is then preferable for a ring laser with opposing waves. Automatic frequency stabilization of such a laser requires elimination of the frequency shift due to the second-harmonic signal produced by the nonlinearity of the absorption cell circuit. Figures 2, references 8: 6 Russian, 2 Western.
[192-2415]

UTILIZATION OF NONLINEAR PROCESSES FOR FORMING HIGH-CONTRAST SUBNANOSECOND LASER PULSES

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 82, No 4, Apr 82 (manuscript received 24 Sep 81) pp 1079-1090

KORMER, S. B., KOCHEMASOV, G. G., KULIKOV, S. M., NIKOLAYEV, Vik. D. and SUKHAREV, S. A.

[Abstract] An experimental study was made with regard to utilization of a nonlinear process, namely transient Mandel'shtam-Brillouin stimulated scattering, for forming short laser pulses with high energy and power contrast in gas under high pressure. An iodine laser was used with "Iskra-4" equipment, including a master oscillator with Mandel'shtam-Brillouin mirror, a plasma or ionine shutter, four amplifiers, and optical decouplers preventing self-excitation in the amplifier stages. Concurrent steady Raman stimulated scattering was avoided by ensuring arise time sufficiently short to allow suppression of this competing process after the energy threshold of Mandel'shtam-Brillouin stimulated scattering has been reached. With the master oscillator specially modified by using a Kerr cell and adding two preamplifier stages, it was found feasible to shorten the duration of laser pulses obtained in an SF_6 (6 atm) + Xe (39 atm) mixture from 0.6 to 0.3 ns (at 50% level) while retaining 1.1 kJ energy in the pulse and maintaining the rise time within 0.17-0.2 ns at single-channel output. Figures 12, references 36: 30 Russian, 6 Western.
[181-2415]

UDC 621.378.325

TRANSVERSE-EXCITATION ATMOSPHERIC PRESSURE CO_2 PULSE LASER WITH COMPOUND PRE-PHOTOIONIZATION AND HIGH INPUT ENERGY DENSITY

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 4, Apr 82 (manuscript received 5 Jun 81) pp 801-803

NGUYEN THO WIONG and PUZEWICZ, ZBIGNIEW, Institute of Quantum Electronics, Warsaw

[Abstract] A reliable CO_2 pulse laser is described that features pre-ionization by vacuum ultraviolet radiation from two sources. The main discharge occurs between two polished copper electrodes with a Chang profile. Pre-ionization

is effected by means of a modified Lamberton-Pearson device with two tungsten wires connected to a high-voltage source and a pair of corona discharge electrodes that increase the local electric field intensity and field emission current. The system also includes Teflon plates with metal foil on the outside surface connected to the cathode and lining both main electrodes, three capacitors (storing, peaking, limiting), and an air discharge gap. Stable and uniform discharge was experimentally generated in mixtures with a high content of molecular gases, the optimum one CO_2:N_2:He = 1:1:4 being capable of admitting an energy intput of 400 J/(l·atm) with wires only, 700 J/(l·atm) with sliding surface discharge only, and 900-1000 J/(l·atm) with both photoionization sources. Various photoionizable organic compounds were tested, triethylamine and diethylaniline yielding the best electrical characteristics and the widest stability range. The resonator was formed by a spherical mirror with a gold-coated surface and a plate of high-purity germanium. Laser emission pulses of 3 J energy were obtained from this device, with an efficiency reaching 10%. Figures 2, references 12: 4 Russian, 8 Western.
[186-2415]

SCATTERING OF MOLECULAR IONS AND THEIR ATOMIC COMPONENTS BY METAL SURFACE

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 82, No 4, Apr 82 (manuscript received 18 Nov 81) pp 1096-1103

YEVSTIGNEYEV, S. A., ZVONKOV, S. N. and CHICHEROV, V. M., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] An experimental study was done to compare the energy distributions of scattered particle fluxes coming from a metal target bombarded by various molecular ions and their atomic components. The equipment consisted of a main ion source for measurements, a separator magnet, an auxiliary ion source for surface cleaning, inside a scattering chamber made of stainless steel and pre-evacuated to residual pressure of $(1\text{-}2)\cdot 10^{-8}$ torr, also a particle detector, an electrostatic-type energy spectrum analyzer with power supply, and an XY-plotter. Rhodium, titanium, gold and copper targets were each bombarded separately with 20 keV N_2^+, C^+, O^+, (energy of atomic ion made equal to its kinetic energy when part of corresponding molecular ion). The results indicate distinct differences between the various energy spectra attributable to peculiarities of scattering molecular ions, namely reflecting particles with energy higher and with energy lower than that of scattered corresponding atoms. The differences in absolute energy levels were found to be much less signigicant, however, an indication that scattering of individual atoms in a molecule is the governing process. In the case of molecular ions, moreover, there is a strong possibility of mutual scattering with attendant momentum transfer. The authors thank C. Yu. Luk'yanov for support and attentiveness, also O. B. Firsov and Yu. V. Martynenko for helpful discussions. Figures 8, references 2: 1 Russian, 1 Western.
[181-2415]

UDC 621.375.8

WAVEFRONT REVERSAL IN MOLECULAR MULTIPASSAGE AMPLIFIER

Minsk ZHURNAL PRIKLADNOY APEKTROSKOPII in Russian Vol 36, No 5, May 82
(manuscript received 14 May 81) pp 730-733

AVER'YANOV, N. Ye., BALOSHIN, Yu. A., DERNYATIN, A. I. and PAVLISHIN, I. V.

[Abstract] Wavefront reversal due to interaction of light and matter is analyzed on the basis of a numerical computer experiment with four-photon mixing in the active medium of a molecular multipassage transverse-excitation atmospheric-pressure CO_2-laser amplifier, taking into account nonlinearity due to partial saturation. The principal parameter determining the feasibility of wavefront reversal in such an amplifier is the amplitude or intensity reflection coefficient for the incident E_3 wave at the "phase coupled" mirror. The amplifier parameters determining the degree of saturation have been optimized for this experiment, with typical cavity length L = 1 m and intensities of both complex-conjugate photoionizing excitation waves $I_1 = I_2 = 0.8 \cdot 10^6$ W/cm^2. Figures 2, references 5: 3 Russian, 2 Western.
[192-2415]

PRODUCTION OF COLOR REFLECTION HOLOGRAMS USING BLEACHED PE-2 PHOTOGRAPHIC PLATES

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 10, 26 May 82 (manuscript received 10 Mar 82) pp 597-599

DENISYUK, Yu. N., ARTEM'YEV, S. V., ZAGORSKAYA, Z. A., KURSAKOVA, A. M., SHEVTSOV, M. K. and SHEDRUNOVA, T. V.

[Abstract] If a holographic image of an object is recorded on various layers of film by light of different wavelengths and these films are processed individually, it is possible to combine them so that the separate monochrome images of the object will merge into a single multicolor image. The results are given here of a study of the possibility of using for this purpose PE-2 photographic plates produced by Soviet industry. Bleaching was performed so that the silver forming the image is oxidized and is converted into the corresponding poorly soluble silver salt. This salt is characterized by its own

characteristic color, by transparency and by stability under the influence of light and has a refraction coefficient greater than that of the gelatin emulsion layer. In bleached holograms the refraction coefficient increases with an increase in the amount of bleached silver, resulting in improvement of the diffraction efficiency of holograms. A special processing method was developed for the purpose of achieving high diffraction efficiency for reflection holograms over the entire visible range of the spectrum when using PE-2 photographic plates. The plates are first hardened in SH-5 hardener for 5 min and are then washed in distilled water for 1 min and bleaching is performed for not less than 10 min in Phillips' bleaching agent, described in an earlier paper (1976) and consisting of 15 g of $Fe(NO_3)_3$, 3.3 g of potassium bromide, 2 g of glycerine, 50 ml of isopropyl alcohol and 50 ml of distilled water to prepare a stock solution. A 1:4 dilution in water is employed as a working solution. The plates are again washed in distilled water for 10 min and dried. All processing steps take place at 20° C. The processing method made it possible to achieve diffraction efficiency of up to 50 percent for wavelengths over the entire optical spectrum and shrinkage of the photographic emulsion was insignificant, equaling not greater than 3 to 4 nm. The shrinkage factor is important for proper color transmission. Individual images were recorded in the red (633 nm) and blue-green (530 and 476 nm) regions of the spectrum and both holograms were cemented together, emulsion to emulsion, with OK-72 optical cement. A good color image was produced by using the processing method described above. Figures 2, references 4: 2 Russian, 2 Western.
[198-8831]

WAVEFRONT REVERSING PLANE PARAMETRIC REFLECTOR

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 9, 12 May 82 (manuscript received 1 Mar 82) pp 554-559

BRYSEV, A. P., BUNKIN, N. F., VLASOV, D. V. and GERVITS, L. L., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] A simple physical interpretation is presented of a plane parametric wavefront reversing reflector, and a brief description is given of the first experiments with it. The parametric wavefront reversal mechanism caused by modulation over time of the Fresnel reflection factor is discussed. Essentially the wavefront reversal mechanism in a plane parametric reflector boils down to the following. If a wave with frequency ω and wave vector $\vec{k}$ is incident at an angle of θ on a plane surface oscillating in phase in the direction of the normal at a frequency of 2ω, then the angle spectrum of reflected waves will contain a component that is reflected strictly in direction $-\vec{k}$. Experiments were conducted with an ordinary acoustic radiator as a parametric wavefront reversing reflector. Two connected plane-parallel piezoelectric plates measuring 75 X 5 X 0.5 mm made of TsTS-22 ceramic immersed in a polyethylene cell with a wall thickness of approximately 0.1 mm, transparent for sound waves, filled with C_5F_{12}, served as the wavefront reversing reflector. The reflector was placed at an angle of approximately 45° to the acoustic axis of the system. A pulse

generator for synchronizing the operation of the entire system, an rf pulse generator, a receiver (part of the YaKR ISSh-13M pulsed wideband radio spectrometer) and a G5-54 controlled-delay pulse generator were used with a double-frequency radio pulse generator, assembled from the ISSh-13M. A type S1-74 oscilloscope was used to observe and record the results and a piezoceramic transducer for radiating and receiving acoustic pulses. Collecting and diverging acoustic lenses and the irregular shape of the cell's entry window served as the phase plate. Radio pulses with frequency of 2 MHz are converted by the piezoceramic radiator into acoustic pulses which are propagated in a water tank in the direction toward the wavefront reversing reflector. After passing the phase plate, the acoustic pulses with distorted wavefront strike the surface of the reflector. Linear scattering of sound by the reflector is observed if the instant of transmitting a radio pulse of doubled frequency does not coincide with the arrival of an acoustic pulse at the reflector. If the instant of transmitting a "pumping" wavefront reversing radio pulse of doubled frequency coincides with the time of arrival at the reflector of an acoustic pulse, then reversal of the wavefront of the acoustic pulse takes place on the surface of the reflector oscillating at the doubled frequency. Figures 3, references 4: 3 Russian, 1 Western.
[197-8831]

CALCULATION OF SPEED OF RESPONSE OF STIMULATED BRILLOUIN SCATTERING MIRROR

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 9, 12 May 82 (manuscript received 18 Feb 82) pp 542-545

SIDOROVICH, V. G.

[Abstract] A theoretical estimate is made of the speed of response of a stimulated Brillouin scattering mirror when the exciting radiation consists of four light beams incoherent relative to one another with slight divergence. When using stimulated Brillouin scattering mirrors in multichannel laser systems the various channels can become mutually incoherent because of unsteady self-strees of the light beams and because of pumping-induced changes of active element permittivity. The interaction of plane monochromatic components of the exciting and Stokes waves through the hypersonic arrays created by them in the scattering medium is discussed, and the possibility of the identity of arrays created by various pairs of interacting waves is taken into account. By this method it is possible to suggest a variant for arranging the exciting beams enabling the best speed of response of the stimulated Brillouin scattering mirror. The question of the maximum permissible width of the spectrum of incoherent exciting radiation at which wavefront reversal still occurs, i.e., of the speed of response of the stimulated Brillouin scattering mirror, has not been studied hitherto. Curves are given showing how increments of components of the Stokes wave depend on parameter Δ/Γ, where Γ represents the width of the spectral line of spontaneous scattering at intensity level 0.5. It is demonstrated that when $\Delta/\Gamma \gtrsim 0.15$ the total increment of the reversed mode is a unit less than

that of the unreversed mode so that wavefront reversal can be observed only with $\Delta/\Gamma < 0.1$. The graphs shown have physical meaning when $\Delta \gg 1/t_i$, where t_i is the duration of the exciting radiation pulse. Figure 1, references 6 Russian.
[197-8831]

INTERACTION OF ANGULAR COMPONENTS OF STOKES WAVE IN EXCITATION OF STIMULATED BRILLOUIN SCATTERING BY LIGHT BEAMS WITH PERIODIC SPACE STRUCTURE

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 9, 12 May 82 (manuscript received 15 Feb 82) pp 532-537

VLASOV, D. V., GARAYEV, R. A. and SIDOROVICH, V. G.

[Abstract] The results are given of an experimental and theoretical study of combined processes accompanying stimulated Brillouin scattering of light beams with a periodic space structure. The simplest case of interaction in a nonlinear medium of two plane pumping waves and two Stokes waves is discussed. This process differs fundamentally from the case of a single plane pumping wave in that coherent scattering of each pumping component is possible in the overall hypersonic array created by both components in combination. This is evidenced by synchronism with the light of third-order nonlinear polarization components corresponding to scattering of pumping waves in the overall hypersonic array. The condition is derived for generation of a combined hypersonic array for two pumping waves and two Stokes waves. The case where the pumping and Stokes waves contain four plane components each with mutually inverted wave vectors is examined. When certain conditions are fulfilled synchronism of scattering of each of the pumping waves in the overall hypersound is made possible. It is shown that in the case of two pumping components rescattering in the overall hypersound tends to compensate the intensities of the Stokes waves inverted in relation to the pumping waves. For excitation of stimulated Brillouin scattering by pumping from four interphased angular components it is necessary to fulfill the threshold condition $9GL \simeq 25$, where G represents the intensity increment corresponding to excitation of stimulated Brillouin scattering by one of the plane pumping components and L is the longitudinal dimension of the nonlinear medium. The theoretical conclusions were confirmed by an experimental study of the interaction of angular components of a Stokes wave in stimulated Brillouin scattering using a setup described in an earlier study (1982). In front of a cell with nitrobenzene was placed a glass plate reflecting part of the Stokes radiation onto a lens with focal length of 1 mm in whose focal plane was placed a camera. The experimental results confirm the theoretical conclusions. Figures 3, references 9 Russian.
[197-8831]

AMPLIFICATION OF 'TRAVELING' HOLOGRAMS IN $Bi_{12}SiO_{20}$ CRYSTALS

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 9, 12 May 82 (manuscript received 29 Jan 82) pp 527-531

STEPANOV, S. I., KULIKOV, V. V., and PETROV, M. P., Physicotechnical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] Crystals of the $Bi_{12}SiO_{20}$ type are highly sensitive to volume holographic recording because of the long average transfer distances of photoinduced electrons which are commensurate with or even substantially longer than the period of the recorded interference pattern, and this fact together with the long average drift length of electrons in an external field applied to a specimen results in a new specific mode for recording and optical erasure of holograms, making it possible to call these "traveling" holograms. When optical erasure is performed in the presence of an external field making possible a sufficiently high average value of the length of electron drift, the electron density maxima in the conduction band will correspond to the minima of the total field, and the recapture of electrons in deep traps results in a shift of the original array in the direction of the external field. The slowing of erasure in an external field makes it possible to increase the stationary amplitude of the hologram, but this is possible only with an optimum recording mode, when the interference pattern to be recorded moves in synchronism with the hologram. Thus, a mechanism exists for amplification of a hologram recorded by a traveling interference pattern. Amplification is caused by effective reduction of the rate of optical erasure of the hologram in a strong external field and is achieved with optimum synchronization of the interference pattern with the recorded hologram. This mechanism was tested in (110)-oriented specimens of $Bi_{12}SiO_{20}$ with their [001] axis perpendicular to the plane of incidence. Holograms were recorded by means of beams of an argon laser with wavelength of 0.51 micron linearly polarized in the plane of incidence and approximately of identical intensity, and reading was performed with an He-Ne laser. Low initial contrast of the pattern to be recorded was achieved by uniform illumination of the specimen with an incandescent lamp through a ZhZS-19 filter. A traveling interference pattern was created by moving one of the mirrors of the interferometer in a straight line. An experimental curve is given showing how the characteristic time for erasure of a hologram by means of the incoherent light of an incandescent lamp depends on the magnitude of the external field. A curve is also shown, illustrating the change in the stationary value of the diffraction efficiency of the array versus the rate of movement of the recorded interference pattern. Figures 2, references 4: 1 Russian, 3 Western.
[197-8831]

OPTOELECTRONICS

UDC 518.74:007.57

ALGORITHMIC DETERMINATION OF DELAY TIME IN DATA TRANSMISSION WITH CONFLICT SITUATIONS IN MULTIMODULAR HIERARCHICAL SYSTEMS

Kiev KIBERNETIKA in Russian No 2, Mar-Apr 82 (manuscript received 17 Nov 81) pp 126-128

ZHUK, OSKAR VENIAMINOVICH, graduate student, Institute of Cybernetics, UkSSR Academy of Sciences, Kiev

[Abstract] A multimodular hierarchical data processing system is considered consisting of functionally oriented modules and a commutation field, the latter composed of switching modules, with a fixed number of communication channels for "each to each" connection of all functional modules. Necessary and sufficient conditions for a conflict situation to arise are, respectively, at least one communication channel simultaneously common to different paths and two or more functional module "transmitters" simultaneously feeding at least one such channel. An algorithm is proposed for minimizing the total delay time in conflict situations through optimization of the sequence of communication channel switching. This is demonstrated on a simple three-level hierarchical scan system. The author thanks Yu. L. Ivas'kiv for suggesting this topic of study. Figures 2, references 3 Russian.
[182-2415]

THEORY OF NONLINEAR OPTICAL FREQUENCY CONVERSION IN CHOLESTERIC LIQUID CRYSTALS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 82, No 4, Apr 82 (manuscript received 25 Nov 81) pp 1159-1169

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[Abstract] Nonlinear optical frequency conversion in a cholesteric liquid crystal is analyzed, assuming first that the pumping light wave propagates along the crystal axis. Considered as a specific example is generation of the third harmonic in the approximation of a fixed pumping wave. The corresponding boundary-value problem is solved, taking into account synchronism under conditions

of diffraction. The maximum conversion efficiency is calculated on this basis and conditions for increasing the efficiency by means of selective reflection are established, also the necessary constraints on pumping wave and material parameters (period of crystal structure, thickness, anisotropy of permittivity). The analysis is extended to oblique incidence of the pumping light wave. The authors thank V. Ye. Dmitrenko for discussing the study. Figures 3, references 13: 9 Russian, 4 Western.
[181-2415]

COMPARATOR LOGIC USING INTEGRATED-OPTICS INTERFEROMETER

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 4, Apr 82
(manuscript received 9 Apr 81) pp 775-777

VOYTENKO, I. G. and RED'KO, V. P., Mogilev Department, Institute of Physics, BSSR Academy of Sciences

[Abstract] An interferometer-type modulator is considered as a device for use in analog processing of data, specifically for comparing pulse signals of different amplitudes and durations. In consists of a stripline waveguide split in the middle into two identical straight channels by a 3-dB divider. The phase of a light wave in each branch is changed by application of an electric field. The merging waves interfere in accordance with their phase difference. The modulation efficiency, ratio of light intensities at the output with and without control voltage respectively, depends on the magnitude of the latter. The device can operate as a comparator of parallel codes. It was tested in comparing two sequences of square pulses, coming from different courses, with an avalanche photodiode serving as receiver. Pulses of equal amplitudes in both channel branches produced the maximum light intensity at the output, corresponding to zero phase difference and taken as logical "1". Pulses of unequal amplitudes produced an output signal proportional to the amplitude difference, any light intensity lower than maximum was taken as logical "0". Pulses of unequal amplitudes and durations produced a step signal at the output, its height proportional to the amplitude difference and its width proportional to the duration difference. The modulator thus can perform the logical operation $Z = XY + \bar{X}\bar{Y}$, equivalence of two logical variables X and Y. The output signal is $Z = 1$ only when both input variables have the same value. Figures 2, table 1, references 3 Western.
[186-2415]

UDC 532.783

WAVEFRONT REVERSAL OF LIGHT IN NEMATIC LIQUID CRYSTAL NEAR LIGHT-INDUCED FREDERICKS TRANSITION

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 4, Apr 82
(manuscript received 3C Mar 81) pp 769-770

TABIRYAN, N. V. and CHILINGARYAN, Yu. S., Yerevan State University

[Abstract] The orientational optical nonlinearity of a nematic liquid crystal near the light-induced Fredericks transition is analyzed, assuming a light beam wider than the crystal cell, on the basis of the variational equation describing the equilibrium distribution of the director field over the crystal volume. This equation has been derived for a light wave linearly polarized along the x-axis and normally incident along the z-axis on the plates of a homeotropically oriented crystal cell. Analysis of the solution to this equation reveals an earlier predicted hysteresis of the Fredericks transition in crystsls with $\alpha < 0$. The feasibility of wavefront reversal for low-power radiation is established for nematic liquid crystals with $\alpha > 0$. The authors thank N. F. Pilipetskiy and O. V. Garibyan for discussing the experimental aspects of the problem. References 11: 10 Russian, 1 Western.
[186-2415]

UDC 537.533.3

DEFLECTION AND FOCUSING OF CHARGED PARTICLE BEAMS IN TRANSAXIAL ELECTROSTATIC SYSTEMS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 4, Apr 82
(manuscript received 11 May 81) pp 735-739

KARETSKAYA, S. P. and FEDULINA, L. V., Institute of Nuclear Physics, KaSSR Academy of Sciences, Alma-Ata

[Abstract] Electron-optical properties of transaxial electrostatic systems are revealed which make such systems suitable as dispersers or deflectors of charged particle beams as well as for forming a dispersionless image of such a beam. The analysis of beam ballistics, on the basis of Grinberg's theory of focusing, is confined to nonrelativistic beams whose axial trajectory lies in a plane and to electric fields which do not vary along one of the coordinates. With the source in a certain position, second-order focusing in the direction of dispersion is always possible. The image, generally a line, can be reduced to a point with the proper voltage across the electrodes. Figures 3, references 3 Russian.
[186-2415]

UDC 53:51

TRANSMISSION OF SPATIALLY NONHOMOGENEOUS IMAGES WITH AID OF OPTOELECTRIC MODULATORS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 4, Apr 82 (manuscript received 21 Sep 80, after final revision 10 Feb 81) pp 695-702

POKATILOV, Ye. P., FOMIN, V. M., VORONOVA, K. A. and RAPOPORT, B. I.

[Abstract] Optoelectric modulators are considered for transmission of spatially nonhomogeneous images. A "Fototitus" modulator consists of a semiconductor (photoreceiver) layer and an optoelectric layer stacked together, the photoelectric effect producing charge carriers in the semiconductor so that its conductivity becomes space modulated. The evolution of the resulting potential distribution in such a device is analyzed on the basis of the quasi-electrostatic field equations curl $E = 0$ and $\text{div}(\check{\varepsilon} E) = (e/\varepsilon_0)(p-n)$ for each layer. Taken into account are the rates of pair formation by absorbed light, intrinsic pair formation, electron and hole entrapment, and recombination. The permittivity tensor in each layer is assumed to be uniaxial. An equation is derived on this basis for the voltage across the optoelectric layer with relaxation control (Maxwell relaxation time much shorter than drift time, diffusion time and characteristic recombination time) or field control of carrier concentration, for quasi-neutrality of the semiconductor layer. The solution to this equation, obtained by Fourier transformation, describes how the voltage spectrum in space evolves as a function of time. Calculations are shown for the amplitudes of the first three components (fundamental first and second harmonics) over a period of 20 s. The authors thank N. S. Churchuk for performing the numerical computations. Figure 1, references 5: 3 Russian, 2 Western.
[186-2415]

TELEVISION OPTICAL PROCESSOR BASED ON CHARGE-COUPLED DEVICE PHOTODETECTORS

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 9, 12 May 82 (manuscript received 4 Jan 82) pp 521-523

GAVRILOV, G. A., GUREVICH, S. B. and SOTNIKOVA, G. Yu., Physicotechnical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] The results are given of a study of the possibility of creating television optical image processing equipment based on charge-coupled device photodetectors. A diagram is presented of a television optical processor for filtering images with a transfer characteristic formed by the two-aperture synthesis method, whereby two filtered images are produced and they are then subtracted. The transparency is placed between frosted glass and a beam splitter and is illuminated by the light of a pulsed source. An image of the slits in the CCD photodetector is formed in optical channels with different transfer characteristics, the image signals are subtracted in an ordinary differential

amplifier, and the difference signal is observed on a video monitor and on an oscillograph. A special circuit is employed to control the operation of matrices and to synchronize them with the pulsed light source. The results are given of 2-dimensional high-frequency filtering of an image in incoherent light, whereby the image, i.e., a figured slit, was defocused in one of the channels. A photograph is presented of the outlined image of the slit along with an oscillogram of the television signal line. It is concluded that it is feasible to use CCD photodetectors in television optical image processing systems even at the present time. The instrument used in the experiment contained 256 X 288 elements and two horizontal registers for input/output of information. Pulsed illumination of the subject makes it possible to double the number of resolvable elements in the image as compared with the ordinary continuous illumination mode requiring division of the light-sensitive surface of the matrix into charge accumulation and storage sections. Pulsed illumination results in a reduction in image defects associated with dark current inhomogeneity. Figures 2, references 3: 2 Russian, 1 Western.
[197-8831]

UDC 533.9.082

USE OF VACUUM ULTRAVIOLET RADIATION FOR STUDY OF FOIL HEATING BY FOCUSED ELECTRON BEAM

Moscow FIZIKA PLAZMY in Russian Vol 8, No 2, Mar-Apr 82 (manuscript received 28 Jul 80) pp 415-421

BABYKIN, M. V., BAYGARIN, K. A., BARTOV, A. V., GORBULIN, Yu. M., DAN'KO, S. A., KALININ, Yu. G., MALKOV, V. N. and SKORYUPIN, V. A., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] In a thin foil absorbing a high-current (10^7 A/cm^2) high-power ($5 \cdot 10^{10}$-$5 \cdot 10^{11}$ W) electron beam there forms a plasma of high concentration with a temperature of 30-50 eV which emits radiation predominantly in the vacuum ultraviolet range (10-1000 A). The intensity of this radiation was measured in experimental studies with vacuum diodes, open and through filters. The diodes specially built for this purpose have aluminum cathodes. Both electrodes are flat so as to ensure optimum dynamic and transient characteristics. The minimum interelectrode gap is 0.3 mm corresponding, at a voltage of 2 kV, to a saturation space-charge current of 200 A/cm^2 and a linear dependence of diode current on radiation flux up to 10^5 W/cm^2. Thin films of nitrocellulose are used as filters. The performance characteristics of such a diode, and correspondingly the results of measurements, are evaluated on the basis of power laws with empirical coefficients and exponents describing the dependence of diode current on source temperature and the relation between radiation power and current signals from two diodes (one with and one without filter). A deflecting magnet behind the foil prevents beam electrons from entering the vacuum diodes. The temperature distribution over the foil surface has been determined from x-ray densitograms and checked against photographs of the interelectrode gap in the beam generating diode, to correct for the effect of scattered foil material. Tests were performed using these vacuum diodes in NPR-2M and "Angara-1" instruments, with the S-60 synchrotron (Institute of Physics USSR Academy of Sciences) and a Planck etalon as radiation sources. The authors thank L. I. Rudakov for helpful discussions, also V. I. Kvochke and S. A. Anevskiy at the All-Union Scientific Research Institute of Optical Physical Measurements, M. N. Yakimenko and the entire staff of the High-Energy Electronics Laboratory at the Institute of Physics USSR Academy of Sciences. Figures 7; references 9: 8 Russian, 1 Western.
[189-2415]

UDC 533.951

NUMERICAL ANALYSIS OF MOTION OF PLASMA ABSORBING LIGHT AT FRONT OF SHOCK WAVE

Moscow FIZIKA PLAZMY in Russian Vol 8, No 2, Mar-Apr 82 (manuscript received 5 May 80, after correction 23 Mar 81) pp 262-268

BAKHRAKH, S. M., KAYNOV, V. Yu., KORMER, S. B., URLIN, V. D., SHANIN, A. A. and YANILKIN, Yu. V.

[Abstract] The two-dimensional transient problem of plasma motion due to release of laser energy has been solved numerically for the case where the front of the luminous detonation wave propagates quasi-steadily from a plane target. The wave front was assumed to be of negligible thickness so that heat conduction and existence of a two-temperature state could be disregarded. Calculations were made for light at the 1.06 μm wavelength in a meduim of molecular nitrogen, taking into account dissociation and single ionization but disregarding the presence of molecular ions. The corresponding system of four equations of state, energy absorption, and plasma dynamics were solved numerically by splitting it on each computation step for evaluation first the gas dynamics and then the change of energy due to absorption of laser radiation. The results reveal the two-dimensional evolution of a plasma jet and the distribution of thermodynamic parameters, pressure and temperature, over its volume. The results differ from those based on the approximate quasi-one-dimensional model. Figures 5, references 19: 17 Russian, 2 Western.
[189-2415]

UDC 537.5

NEW TYPE OF IONIZATION WAVE AND MECHANISM OF POLARIZATION SELF-ACCELERATION OF ELECTRONS IN GAS DISCHARGES UNDER HIGH OVERVOLTAGE

Moscow DOKLADY AKADEMII NUAK SSSR in Russian Vol 263, No 1, Mar 82 (manuscript received 2 Oct 81) pp 76-79

BABICH, L. P.

[Abstract] It is demonstrated that in gas discharged under sifficiently high overvoltage the self-consistent development of ionization and acceleration processes results in the appearance of a new type of ionization wave propagated not only at speeds of $v_f \gg v_-(E_f)$, where $v_-(E_f)$ is the rate of drift of frontal electrons, but also of $v_f > c\sqrt{1 - [mc^2/(mc^2 + eU_0]^2}$. Avalanche chains are formed in the "reaction zone," all of whose links develop almost simultaneously and this makes possible synchronization of the motion of the field wave and of accelerated electrons, which results in self-acceleration, characterized by a resonance polarization acceleration mechanism. In nanosecond gas discharges under considerable overvoltage self-acceleration is responsible for the generation of high-energy electron streams at the front of a streamer. The physical fundamentals of the resonance mechanism, sustained over time, are discussed. The ionization wavelength, λ, represents the dimension of the "reaction zone"

within which the ionization of atoms, polarization of the medium and acceleration of electrons take place. The simultaneous development along this wavelength of a great number of electron avalanches synchronizes the motion of accelerating electrons, the ionization wave and wave of the amplified field. The field wave and electrons accelerated in it appear to be linked by avalanche chains, as it were. Electron avalanches develop with sufficiently high E_f/P, where E_f represents the amplified field and P represents the pressure. The conclusions arrived at are based on the fact that under sufficiently high overvoltage, $\Delta U/U_s$, the classical streamer discharge mechanism is replaced by a mechanism in which the decisive role is played by the phenomenon of the "runaway" of electrons in the electric field. The results of Soviet studies (1974-1978) are regarded as the first observations of and research on the effect of self-acceleration of charged particles in gas discharges. References 15: 10 Russian, 5 Western.
[196-8831]

PROPAGATION OF SHOCK WAVES IN DECAYING PLASMA

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 9, 12 May 82 (manuscript received 24 Feb 82) pp 551-554

KLIMOV, A. I., KOBLOV, A. N., MISHIN, G. I., SEROV, Yu. L., KHODATAYEV, K. V. and YAVOR, I. P., Physicotechnical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] The results are given of a study of the passage of a shock wave through the decaying plasma of a glow discharge at instants following its quenching. The experimental apparatus used included, for the purpose of quenching the glow discharge, a circuit for shunting the interelectrode gap, assembled from a TGI-500/16 thyratron and triggered with short delays by means of a signal from a delayed pulse generator. The generator was synchronized by means of the signal triggering the thyratron, which in turn controls an electric discharge shock tube. A reversed switching circuit was used for the purpose of producing delays longer than the time for the shock wave to travel the distance from the shock tube to one of the electrodes. The voltage between the two electrodes after quenching of the discharge was not greater than 1 V. The rate of propagation of the shock wave was determined with accuracy of approximately 5 percent from the time it took for the wave to reach a piezoelectric transducer and from the known distance of 6 cm between the two electrodes of the discharge gap. The intensity of radiation from the discharge and its change after cutoff of the current were recorded by means of a photomultiplier tube. Experiments were conducted in the plasma of the air at various current densities and pressures in the chamber, and a series of oscillograms was obtained, of signals from the piezoelectric transducer with various delay times between the moment of cutoff of the current and entry of the shock wave into the plasma. The results demonstrate that the speed of the shock wave in the decaying plasma depends on the delay time, that with an increase in the delay time from 0 to about 1 s the amplitude of the shock wave in the plasma increases uniformly, that the width of the shock compression zone is reduced with an increase in delay time, and that

when the delay time is greater than 10^{-3} s the curvature of the shock wavefront increases. Under the conditions of the given experiments the energy in the shock-compressed decaying plasma is greater than the energy of compression in propagation of the shock wave in air. This confirms the hypothesis that the energy accumulated in internal degrees of freedom of particles in the glow discharge is released behind the shock wavefront. Figures 3, references 2 Russian.
[197-8831]

ACCELERATION OF SLOW LIGHT-BURNING WAVES

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 9, 12 May 82 (manuscript received 1 Feb 82) pp 537-541

LOSEVA, T. V. and NEMCHINOV, I. V., Institute of Earth Physics imeni O. Yu. Shmidt, USSR Academy of Sciences, Moscow

[Abstract] A brief survey is presented of studies relating to acceleration of slow light-burning waves. These waves have been observed when propogated toward the radiation of a neodymium laser after they had been initiated by an electric discharge or breakdown from an auxiliary laser. Under atmospheric pressure with a laser beam of small diameter and formation of a plasma the dominant mechanism in propagation of the laser spark is molecular and electronic heat conduction, and with laser beam dimensions on the order of 10 to 30 cm only a small part of the laser radiation is absorbed in the plasma, but with dimensions on the order of 1 cm radiant transfer of energy begins to play an important role. Theoretical and experimental studies have been made of fast light-burning waves propagated from an obstacle. Then expansion of the plasma generates strong shock waves and the pressure is far greater than atmospheric, resulting in great optical thickness of the plasma layer. The laser radiation is completely absorbed in the plasma and since the thermal radiant flux in it is considerable the radiation mechanism for propagation of the plasma front is the dominant one. An important role in initiation of fast waves is played by vaporization of the obstacle. Under sufficiently high pressure the origin of a plasma in the vapors enables strong absorption of the laser radiation. These waves can also originate with special initiation of the plasma. If the plasma formed as the result of breakdown or electric discharge is able to expand to atmospheric pressure by the start of the main pulse, while maintaining a sufficiently high temperature, a fast absorption wave can originate from a slow one. A simple model of this phenomenon is presented by solving an equation for the energy of an expanding slightly absorbing plane layer of plasma. The plane unsteady radiation gas-dynamic problem is solved taking into account in detail the spectral composition of the radiation. For this calculation the method of averaging radiation transfer equations was used, along with detailed tables of the optical properties of burning air. The heat conduction mechanism was taken into account in addition. Tables of molecular and electronic heat conduction coefficients were employed. It was assumed that at the initial moment of time in the air under atmospheric pressure a plane layer forms, 1 cm thick, with the required energy for the

initiating blast equaling about 5 J/cm^2. The evolution of this layer is discussed under the effect of radiation of 1 eV with flux density of 1 MW/cm^2. The initial optical thickness of the layer was approximately 0.01. Curves are shown for distribution of the temperature over the mass of the layer and over its thickness at various moments of time, and for distribution of laser radiation flux and of the "internal" heat flux of the plasma's radiation over the thickness of the layer. The optical thickness of the layer increased exponentially with a critical energy of about 150 J/cm^2 and at the end of 150 microseconds the velocity of the plasma boundary increased from 20-30 m/s to 200 m/s, resulting in an increase in pressure as compared with atmospheric, an increase in optical thickness, great acceleration of the wavefront and transition of the slow light-burning wave into a fast one. Figures 2, references 17: 14 Russian, 3 Western. [197-8831]

SUPERCONDUCTIVITY

PECULIARITIES OF NONHOMOGENEOUS CURRENT STATE IN WIDE SUPERCONDUCTOR FILMS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 82, No 4, Apr 82 (manuscript received 7 Aug 81) pp 1262-1266

D'YACHENKO, A. I., TARENKOV, V. Yu. and STUPAKOV, V. V., Donetsk Physico-Technical Institute, UkSSR Academy of Sciences

[Abstract] Sandwich structures consisting of an SiO_2 film ($1 \cdot 10^{-6}$ cm thick) between two granular aluminum films (lower film $3 \cdot 10^{-6}$ cm thick and 0.3 cm wide, upper film $6 \cdot 10^{-6}$ cm thick and 0.1 cm wide) were studied in a superconductivity experiment, after having been deposited on glass substrates in an oxygen atmosphere under a pressure of 10^{-4} torr. Their current-voltage characteristics were measured in a cryostat at a temperature of $(0.7-0.8)T_c$ (superconducting transition temperature of aluminum $T_c=1.8-1.9$ K, coherence length $\varkappa = 5 \cdot 10^{-6}$ cm, Ginzburg-Landau parameter $\xi = 8-10$), shielded from external magnetic fields. The peculiar shape of the current-voltage curve, with a series of widening steps, is analyzed on the basis of the superconducting d.c. transformer model and the equations of motion for an eddy-current structure. It is attributed to the nonhomogeneous state in wide films with a large number of eddy strings which drag the signal. The authors thank V. M. Svistunov for formulating the problem and discussing the results. Figures 2, references 10: 6 Russian, 4 Western.
[181-2415]

MATHEMATICS

UDC 519.21

LAW OF LARGE NUMBERS FOR RANDOM VECTORS WITH VALUES OF ELEMENTS IN l_p $(1 \leq p < \infty)$

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian No 7, Issue 2, Apr 82 (manuscript received 26 May 81) pp 111-115

SKOVORODA, B. F.

[Abstract] The law of large numbers is applied to a quasi-stationary sequence and a quasi-multiplicative sequence of random vectors. Two convergence theorems are proved, each with the aid of a lemma, for each kind of sequences of such vectors with values of elements in l_p $(1 \leq p < \infty)$, $\alpha = \min\{1;p/2\}$ and then $\beta = \max\{1;2(p-1)/p\}$. The first pair of these theorems generalizes Serfling's B and β theorems for quasi-stationary sequences. References 5: 2 Russian, 3 Western.
[188-2415]

UDC 517.5

TREND OF INCREASE OF LEBESGUE CONSTANTS IN POLYHEDRAL FOURIER SUMS

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian No 7, Issue 2, Apr 82 (manuscript received 31 Mar 81) pp 110-111

PODKORYTOV, A. N.

[Abstract] The rate of increase of Lebesgue constants (norms of operators) in partial sums of multiple Fourier series is estimated on the basis of a theorem applicable to any polyhedral representation. The theorem, proved with the aid of a lemma pertaining to a simplex, demonstrates that the Lebesgue constants increase as the power of the logarithm in the upper estimate for a cube according to E. S. Belinskiy. References 6 Russian.
[188-2415]

UDC 518.9

DYNAMIC GAMES WITH INFINITE NUMBER OF PLAYERS: FUNDAMENTAL CONCEPTS

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian No 7, Issue 2, Apr 82 (manuscript received 3 Sep 81) pp 69-75

PETROSYAN, L. A. and ULANOV, V. A.

[Abstract] Fundamental concepts are developed for a dynamic game with a continuum of players. The set of players is identified with a segment I = [0,1] on which is given a nonatomic probabilistic measure. The game dynamics can be specified in terms of a system which, with the initial conditions fixed, in turn defines a semidynamic system. Analysis of such a game is facilitated by using the σ-algebra of Borel sets on segment I. With the payoffs assumed to be transferable, the characteristic function is constructed for a cooperative game and the payoff functional for the first (maximizing) player is determined in the corresponding set. These concepts are then applied to two games where the union of piecewise-intersecting segments represents the first player so that the characteristic function can also be determined in M-algebra. The results of both determinations are compared on the basis of two theorems, and the characteristic function is found to have the property of superadditivity. Next are considered games which involve payoff sharing, where none of the players alone can affect the outcome so that sufficiently large coalitions must be taken into account. Several definitions are added and two theorems are proved pertaining to existence and stability of the share function, the set of additive game kernel functions, and the conditionally optimum trajectory. References 4 Russian. [188-2415]

UDC 007:519.241.2

ANALYSIS OF STATIONARY SEMI-MARKOV PROCESSES BY METHOD OF FICTITIOUS STATES

Kiev KIBERNETIKA in Russian No 2, Mar-Apr 82 (manuscript received 12 Oct 79) pp 91-94

GRINSHPAN, LEONID ABRAMOVICH, candidate of technical sciences, group director, special design and technological office, Institute of Engineering Cybernetics, BSSR Academy of Sciences, Minsk

[Abstract] Stationary ergodic semi-Markov processes, which occur in queuing systems, are analyzed by a decomposition method that involves fictitiously increasing the period of the embedded Markov chain. The method is based on two concepts: simple path from one state to an adjacent one and minimum normal vicinity of a state. It is validated by a theorem pertaining to equality of stationary probability distributions of two processes, original and expanded ones, and to similarity of paths on two corresponding graphs. It is demonstrated on a queuing network with exponential distribution of waiting time, simulating a two-loop computer network. Figures 3, references 6: 5 Russian, 1 Western. [182-2415]

UDC 518.9

PURSUIT BY SIMPLE MOTION WITH TWO KINDS OF CONSTRAINTS ON CONTROL

Kiev KIBERNETIKA in Russian No 2, Mar-Apr 82 (manuscript received 1 Nov 79)
pp 80-84

BARDADYM, TAMARA ALEKSEYEVNA, candidate of physico-mathematical sciences, junior scientist, Institute of Cybernetics, UkSSR Academy of Sciences, Kiev

[Abstract] Analysis of differential games is extended to a game with simple motion where the controls satisfy both geometrical and integral constraints. Two theorems and a corollary are proved, with the aid of three lemmas pertaining to discontinuity and termination time. The pursuit game

$$\dot{x}=u \qquad x\in R^n$$

$$\dot{y}=v \qquad y\in R^n$$

$$M=\{x,y:x=y\}$$

with constraints

$$\|u\|\leq\alpha, \qquad \int_0^\infty \|u(\tau)\ {}^2 d\tau\leq\mu^2$$

$$\|v\|\leq\beta, \qquad \int_0^\infty \|v(\tau)\|^2 d\tau\leq\nu^2$$

is considered as an example. The author thanks B. N. Bshenichnyy, N. Z. Schor, G. Ts. Chikriy and M. S. Nikol'skiy for attentiveness and helpful comments. [182-2415]

UDC 517.957

APPROXIMATE-SOLUTION ALGORITHM FOR SYSTEMS OF NONLINEAR EQUATIONS

Kiev KIBERNETIKA in Russian No 2, Mar-Apr 82 (manuscript received 21 Mar 80)
pp 74-79

BABICH, MIKHAIL DANILOVICH, candidate of physico-mathematical sciences, senior scientist, and SHEVCHUK, LUDMILA BORISOVNA, senior engineer, both of the Institute of Cybernetics, UkSSR Academy of Sciences, Kiev

[Abstract] One of the most difficult problems in solving nonlinear equations and systems of such equations on a computer is finding the initial approximation from which iterations will lead to an acceptable result. Here an algorithm is shown which within a prescribed region separates all isolated solutions to a system of nonlinear algebraic and transcendental equations, finds the initial approximations for subsequent iterations and then approximates all separate solutions with any desired accuracy attainable by the computer. This εs-algorithm is based on the method of ε-grids, applicable to nonlinear operator equations with a completely continuous operator in a convex compact space, and involves transforming the sequence of ε-grids in this compact space while

satisfying certain conditions. The algorithm is demonstrated on the general system of n equations $u_n=f_n(u_1,u_2,\ldots, u_n)$. Its basic steps are analysis and transformation of equations, construction of grids in an n-dimensional cube R^n selected as the compact space, sampling of points in these grids, forming and determining resolvent sequences. A theorem is stated and proved which validates the final step. The algorithm has been programmed in FORTRAN for a BESM-6 computer, the latter usually requiring an external storage for fast increasing data arrays. The algorithm was tested experimentally on the system of equations

$$u_1 = \frac{3}{4}u_1 + \frac{1}{4}\sin\delta u$$

$$u_2 = u_2 - u_1u_2 + \frac{1}{8}$$

and on the equation

$$u(x) = \frac{1}{2}\int_0^1 \sin xy[u(y)]^2dy+1$$

Table 1, references 14 Russian.
[182-2415]

UDC 518.9

APPROXIMATE SOLUTION OF PURSUIT-EVASION PROBLEMS IN DIFFERENTIAL GAMES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 263, No 1, Mar 82
(manuscript received 2 Sep 81) pp 30-34

OSTAPENKO, V. V., Institute of Cybernetics, Ukrainian SSR Academy of Sciences, Kiev

[Abstract] As an example of problems relating to approximation in differential games, an approach is suggested that makes it possible to approximate in Hausdorff metrics the value of the primary operator by a set permitting a more structured construction, and making it possible in a number of cases to estimate this proximity. The differential games discussed are described by the equation $\dot{z} = f(z, u, v)$, where $z \in Z$, $u \in U$, $v \in V$, and Z is a finite-dimensional Euclidian space with a dot product of $\langle\cdot,\cdot\rangle$ and U and V are compact sets in finite-dimensional Euclidian spaces. The terminal set, M, and the set of phase constraints, N, are assumed to be compact and M is contained in N. Relative to function f and sets U and V it is assumed that f(z, u, v) is continuous relative to the set of variables and doubly continuously differentiable in terms of z; that a constant C exists such that for all $z \in Z$, $u \in U$ and $v \in V$, $|\langle z,f(z, u, v)\rangle| \leq C(1 + \|z\|)$; and that set f(z, U, v) is convex for all $z \in Z$ and $v \in V$. The permissible controls of the players, P (pursuer) and E (evader), represent measurable functions $u(\tau)$ and $v(\tau)$ with values in U and V respectively. Pursuit-evasion games with a fixed and unfixed time for completion of the game are described fully by primary operators $\tilde{T}_{N,t}(M)$ and $P_{N,t}(M)$, which place in correspondence with set M the set of all points from which player P can, by playing in ε-strategies, develop a path to set M not

later than during time t and precisely at instant of time t. The path does not go beyond the limits of set N. The conditions are found under which set $\tilde{T}_{N,t}(M)$ $(\tilde{P}_{N,t}(M))$ can be approximated by set $\Theta^n_{N,h}(M)$ $(\pi^n_{N,h}(M))$, where $nh = t$ and Θ^n represents the n-th iteration of operator Θ, and an estimate is made of their proximity. A description is given of strategies with which the opponents can play the game in order to complete it with a certain error. It is assumed that $h > 0$. References 7 Russian.
[196-8831]

CSO: 1862

- END -

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ACOUSTICS

UDC 534.2

EFFECT OF RANDOM PHASE AND AMPLITUDE ERRORS ON IMAGE QUALITY IN ACOUSTIC HOLOGRAPHY

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82
(manuscript received 6 Mar 81) pp 30-35

GIK, L. D., Novosibirsk

[Abstract] Acoustic holography with one source of a harmonic probing signal and N receivers in the observation plane is considered for an object lying below the signal source at a distance from the observation plane much larger than the distances from receivers to source. The distances of all points of the object from the observation plane are assumed to be of the same order of magnitude. The holographic image is in this case reconstructed not in the form of a Kirchhoff integral but as the sum of signals recorded by the receivers and with phases referred to a point. Assuming that the image is reconstructed correctly in the absence of phase and amplitude errors, first the effects of phase errors alone and then the effects of amplitude errors alone on the statistical characteristics of the signal vector are analyzed with the signal vector resolved into its sine and cosine components. The results indicate that the phase errors can be compensated by increasing the number of receivers and that, with basic linearity and stability requirements satisfied, the effect of amplitude errors is negligible. Figures 4.
[202-2415]

ACOUSTOOPTICAL MEASUREMENT OF MULTIPASS NOISE AMPLIFICATION IN n-InSb

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 24, No 5, May 82
(manuscript received 16 Nov 81) pp 1302-1307

DOMARKAS, A. , D'YAKONOV, A. M. and CHIPLIS, D., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] Multipass amplification of acoustoelectric noise in n-InSb occurs, in absence of a magnetic field, as a result of conversion of acoustic modes

during their reflection at crystal boundaries. An effective acoustooptical method utilizing diffraction of light by sound has been developed for determining the spectral and modal content of acoustic noise in such semiconductor devices. Application of this method in the middle infrared range is difficult, because the diffraction efficiency of noncoherent sound is inversely proportional to the fourth power of the optical wavelength and is thus much lower for 10.6 μm radiation than for visible light. The long wave of infrared radiation also sets an upper limit on the frequency range of acoustic noise measurable by this method. The optical part of the equipment includes an $He-N_2-CO_2$ laser operating in the pulse mode at a 50 Hz repetition rate, delivering pulses of 10 W power and 2-3 ms duration. The pulses are reflected by a 45° mirror and then chopped by a rotating disk into 200 μs pulses. A beam splitter divides these light pulses along two paths to the InSb specimen: one beam is reflected by another 45° mirror before passing through a diaphragm and a lens, the other beam passes through a polarizer before being reflected by a rotating mirror and then passing through a lens. From the InSb specimen light passes through another lens to an HgCdTe photoresistor. Acoustoelectric instability in the specimen is excited by means of a drift-pulse generator, the latter triggered by the chopper through a trigger-pulse generator and a repetition-rate divider. The equipment includes also a microwave bias-voltage generator for heterodyning and a 30 MHz amplifier followed by an oscillograph at the output of the HgCdTe photoreceiver. Specimens were cut from an nInSb ingot with electron concentration $n = 5 \cdot 10^{13}$ cm^{-3} and electron mobility $\mu = 6.8 \cdot 10^5$ $cm^2/V \cdot s$, their dimensions 19 $[110]$ x 4 $[1\bar{1}0]$ x 4 $[001]$ mm. Intensity of the transverse noise component was measured at various distances from and various angles to the anode. Each noise component decayed after the drift field had been turned off, the nonpiezoactive slow transverse component almost according to normal lattice attenuation and the piezoactive fast transverse component much faster. The authors thank V. V. Lemanov and Yu. V. Ilisavskiy for helpful discussion, I. L. Drichko for assistance, also V. V. Shein and V. A. Yankovskaya for preparing the specimens. Figures 5, table 1, references 5: 3 Russian, 2 Western.
[226-2415]

FILM LENSES FOR SURFACE ACOUSTIC WAVES

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 11, 12 Jun 82 (manuscript received 3 Mar 82) pp 673-676

BORODIY, Yu. N., GRANKIN, I. M., GONCHAROV, A. D. and KOBA, S. I., Kiev Polytechnic Institute imeni Semicentennial of Great Socialist October Revolution

[Abstract] Focusing plane surface acoustic waves on an isotropic substrate requires transformation of their front to a cylindrical one, which can be

achieved by means of a laminate structure. An experimental study was made of acoustic lenses consisting of 1.1-3.6 μm thick ZnO films deposited on fused-quartz substrates by ion-plasma sputtering in an Xe-Ar atmosphere and oriented with their c-axis perpendicular to the substrate surface. A plane surface acoustic wave with a parallel front was, upon reaching the base of such a lens, indeed focused according to calculations. Such a lens (3.6 μm thick film on 18 mm thick substrate) was tested with a nonapodized interdigital transducer (20 prong pairs, 17.5 mm aperture, 70 μm period, ZnO coating and shielding electrode) for focusing surface acoustic waves with velocities of 3410 and 3165 m/s at a distance of 35 mm. Amplitude measurements revealed an almost sinusoidal distribution in the focal plane. Phase measurement revealed a plane front inside the lens and a cylindrical one outside the lens, also an almost plane front in the focal region. Measurements were made with a laser probe. Such acoustic lenses were also tested with small-aperture transducers underneath and found to be capable of focusing only waves propagating near the acoustic axis. Figures 2, references 4: 3 Russian, 1 Western.
[227-2415]

THEORY OF SOUND ABSORPTION BY LATTICE IN 'DIRTY' CRYSTALS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 82, No 5, May 82 (manuscript received 14 Oct 81) pp 1551-1561

GULYAYEV, Yu. V. and KOZOREZOV, A. G., Institute of Radio Engineering and Electronics, USSR Academy of Sciences

[Abstract] A theory is constructed for sound absorption in real dielectric crystals, with impurities and defects, which covers a wide frequency range and in which the "clean" crystal Akhiyezer (low-frequency) and Landau-Rumer (high-frequency) mechanisms appear as special cases. Perturbation of the phonon system by acoustic waves is described on the basis of Boltzmann kinetics with the absorption coefficient, in the linear approximation with respect to wave amplitude, proportional to the real part of the nonequilibrium increment added by acoustic waves to the phonon distribution function. The latter is calculated with aid of the phonon-phonon collision integral. The frequency dependence of the absorption coefficient is determined by the role of phonon-phonon interaction and diffusion processes, the former at thermal energy levels predominant in the low-frequency range and the latter predominant in the high-frequency range. There is an intermediate range within which the frequency dependence of the absorption coefficient weakens and vanishes before the Akhiyezer mechanism becomes operative again. The authors thank V.L. Gurevich for valuable comments. Figure 1; references 14: 9 Russian, 5 Western.
[225-2415]

EFFECT OF GAMMA IRRADIATION ON OPTICAL CHARACTERISTICS OF RUBY AND RUBY LASERS WITH GALLIUM AND TITANIUM IMPURITIES

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: FIZIKA in Russian Vol 17, No 2, Mar-Apr 82 (manuscript received 1 Nov 80) pp 91-96

ATABEKYAN, R. R., VOSKANYAN, R. Ye., GEVORKYAN, V. A., YERITSYAN, G. N., YEZOYAN, R. K., SARKISOV, V. Kh. and SAKANYAN, A. G., Yerevan Institute of Physics and Kirovakan Chemical Plant

[Abstract] An experimental study was made to determine the effects of γ-radiation on α-Al_2O_3 crystals with Cr, Cr+ Ga, Cr+ Ti impurities (0.05 wt.% Cr_2O_3, 10^{-4}-10^{-3} wt.%Ti_2O_3, 1-2.5 wt.% Ga_2O_3). All specimens were heat treated at 1950°C in vacuum and 1250°C in oxygen. Optical anisotropy and optical uniformity were measured with an IPL-452 conoscope and a universal Twyman interferometer respectively. Absorption spectra were recorded with an SF-8 spectrophotometer and emission characteristics were measured in an L-1 laser setup with an IFP-600 xenon flash lamp in a 600 μF - 100 μH circuit, before and after irradiation from a Co^{60} γ-source. The results indicate that the emission efficiency of crystals with gallium impurity is higher than that of "pure" crystals. They are also gamma resistant, inasmuch as after irradiation they are restored by flashes from a xenon lamp without supplementary heat treatment. Figure 1, tables 1, references 16: 6 Russian, 10 Western.
[199-2415]

OPTICAL AMPLIFICATION IN ZnTe SINGLE CRYSTALS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 24, No 5, May 82 (manuscript received 13 Jun 81, final edition received 11 Jan 82) pp 1431-1433

BALTRAMEYUNAS, R. and KUOKSHTIS, E., Vilnius State University imeni V. Kapsukas

[Abstract] An experimental study was made of optical amplification in cubic ZnTe single crystals. Specimens were grown from melt and then excited with

third-harmonic emission from a YAG:Nd^{3+} laser. The wavelength spectra of gain were measured by the "thin strip" method at 4.2 and 77 K. The results indicate predominance of radiative processes in electron-hole drops, but only in very pure specimens, distortions in form of cutoff at the short-wave edge being caused by absorption in the interdrop space. In defective specimens there occurs no radiative recombination in electron-hole drops and radiative processes in dense exciton gas predominate. Here the gain has four peaks, two of them in the long-wave range attributable to radiative transitions I-LO (annihilation of bound exciton with emission of one optical phonon) and A-LO (first phonon repetition of free exciton) respectively. The other two peaks in the short-wave range are difficult to identify, but they probably correspond to exciton-exciton interaction and to a bound exciton respectively. The spectra of gain at 77 K indicate strong absorption at the short-wave edge and reveal two peaks, a longer wave peak exactly within the range of exciton annihilation with emission of two phonons and a shorter-wave peak which apparently corresponds to break-even between competing emission and absorption processes. Figures 2, references 14: 7 Russian, 7 Western.
[226-2415]

DEFECTS IN ION-IMPLANTATION LAYER OF FERRITE-GARNET FILMS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 24, No 5, May 82
(manuscript received 16 Nov 81) pp 1308-1312

LINKOVA, D. Ye., OSUKHOVSKIY, V. E., RUDIK, Ye. I., YUDINA, L. A., VETER, V.V., CHIRKIN, G. K. and MILYAYEV, Yu. K., Far-Eastern State University, Vladivostok

[Abstract] A morphological study was made of (EuTmCa)$_3$(FeGe)$_5$O$_{12}$ ferrite-garnet films with ion-implantation layer. Single-crystal films of this material were deposited on GGG [expansion not given] substrates by the liquid-phase epitaxial process. Specimens were irradiated with 100 keV H_2^+ ions in doses of $1\cdot10^{16}$-$7.5\cdot10^{16}$ cm^{-2} and then etched with orthophosphoric acid (1.85 g/cm^3) at 130°C. While the etching rate of plain films is 33 Å/s and constant, the etching rate of films with ion implantation was found to be much higher and proportional to the concentration of radiative defects. The depth of the implantation layer was 0.45 μm regardless of the irradiation dose. The surface reliefs were examined under an MBI-6 optical microscope and a JSM-IZ scanning electron microscope. Experimental data, supported by theoretical analysis of collisions between impinging ions and atoms of the film material with attendant competing generation and annihilation of point defects, indicate that the mean (statistical) size of etching pits increases proportionally with the irradiation dose but their volume concentration increases nonlinearly to a maximum at the irradiation dose of $2.5\cdot10^{16}$ cm^{-2}. Coalescence of vacancies under higher irradiation doses appears to result in formation of pores((three-dimensional defects) rather than dislocation loops. Figures 5, references 13: 7 Russian, 6 Western.
[226-2415]

UDC 621.315.592

LONGITUDINAL PROPAGATION OF MAGNETOPLASMA SURFACE WAVES OF SEMICONDUCTOR-METAL INTERFACE

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 4, Apr 82 (manuscript received 27 Aug 81) pp 712-714

ZAKHAROV, V. A., Sverdlovsk Branch, All-Union Scientific Research Institute of Metrology imeni D. I. Mendeleyev

[Abstract] Existence of magnetoplasma surface waves on a semiconductor-metal interface and their propagation in the direction of the magnetic field are analyzed, specifically for an n-type semiconductor, assuming first no collisions and a correspondingly zero frequency of carrier momentum relaxation ν_r. Solution of the dispersion equation reveals that the frequency range of such waves is not simply $0 < \omega < \omega_c$ (ω_c - cyclotron frequency) but $\omega < \min(\omega_c, \omega_p)$ (ω_p - plasma frequency) and thus also determined by the plasma frequency. Attenuation of such waves depends on the relative magnitudes of the three frequencies ω_c, ω_p, ν_r in the semiconductor, according to the expression obtained for the longitudinal component of the wave vector, it becomes weaker as ν_r decreases and as ω_c increases (stronger mangetic field). When $\omega_c \gg \omega_p$, $|\omega + j\nu_r|$ the ratio of imaginary part to real part of the longitudinal wave vector component increases with increasing magnetic field intensity almost proportionally to the ratio ω_p/ω_c at any ratio ν_r/ω. References 11: 3 Russian, 8 Western.
[214-2415]

UDC 621.315.592

ABSORPTION OF ELECTROMAGNETIC WAVES BY TWO-DIMENSIONAL PLASMONS IN THIN FILMS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 4, Apr 82 (manuscript received 29 Apr 81) pp 625-629

VITLINA, R. Z. and CHAPLIK, A. V., Institute of Semiconductor Physics, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] A theory is constructed describing absorption of electromagnetic waves by two-dimensional plasmons in a quantum film or inversion channel of an MOS structure with two populated subbands. Electrons are assumed to be scattered by impurities only, which has been verified experimentally in silicon MOS structures and in GaAs thin films in GaAs/GaAlAs structures at liquid-helium temperatures. The equation of kinetics of the Poisson equation are solved exactly for the case of scattering by short-range centers, the field

term in the equation of kinetics including not only the external electric field but also the field of a plasma wave. For the more general case of an arbitrary scattering potential, with the probability of scattering assumed to depend on the angle difference only, the collision term in the equation of kinetics is integrated with respect to electron acceleration and the probability of scattering is resolved into cylindrical harmonics for an approximate solution. The authors thank L. I. Magarill and I. A. Gilinskiy for helpful comments. References: 4 Western.
[214-2415]

UDC 621.315.592

PROPERTIES OF CHROMIUM-DOPED SILICON

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 4, Apr 82 (manuscript received 23 Dec 80) pp 582-586

MUMINOV, R. A., DZHULIYEV, Kh. Kh., MAKHKAMOV, Sh. and MAMADALIMOV, A. T., Physico-Technical Institute imeni S. V. Starodubtsev, UzSSR Academy of Sciences, Tashkent

[Abstract] Energy levels produced in n-type and p-type silicon by doping with chromium were studied by several methods. Specimens of n-Si and p-Si with electrical resistivity σ = 3-100 ohm·cm were doped with chromium by slow diffusion under vacuum at 1000-1250°C for 0.15-14 h, with subsequent oil quench. The electrical resistivity of doped n-Si had not changed, that of doped p-Si had increased to 10^5 ohm·cm. Capacitance-voltage characteristics of n-si < Cr > and p-Si < Cr > diodes were measured at 77 K, with reverse 8 V bias and after irradiation with light $\nu >> E_g$ from the side opposite to the p-n junction. The temperature dependence of the rate of thermal emission from deep levels was measured by the method of isothermal relaxation of dark capacitance and photo-stimulated capacitance. The energy spectra of photoconduction (impurity photoconduction) were measured at 4.2 K with 6 V bias. The results indicate formation of donor levels with ionization energy $E_c - 0.22$, $E_c - 0.55$, $E_v + 0.39$ eV in n-Si and $E_v + 0.31$ eV in p-Si. The different levels in the two types of silicon are due to different interactions of chromium with fine acceptor and donor impurities, these interactions depending on the N/M ration(N- concentration of fine levels, M- concentration of deep levels). The authors thank A. A. Lebedev for providing the facilities for measurement of photoconduction spectra at liquid-helium temperature and for helpful suggestions. Figures 4; references 18: 14 Russian, 4 Western.
[214-2415]

UDC 621.315.592

DIFFERENCES BETWEEN RADIATIVE DEFECTS PRODUCED IN GaAs DURING IMPLANTATION OF PHOSPHORUS AND ALUMINUM IONS RESPECTIVELY

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 4, Apr 82 (manuscript received 15 Dec 80) pp 577-581

DAVIS, J., TASHLYKOV, I. S., and THOMPSON, D. A., Chalk River Nuclear Laboratory, Canada; Scientific Research Institute of Applied Problems in Physics imeni A. N. Sevchenko, Belorussian State University, Minsk; McMaster University, Canada

[Abstract] A study was made, by the backscattering method, of radiative defects (ternary compounds) produced in GaAs crystals by P^+ and Al^+ ions channeling through during their implantation. In the experiment P^+ and Al^+ ions with 60 keV energy were implanted in GaAs single crystals in doses of $1.2 \cdot 10^{12}$-$8 \cdot 10^{16}$ ions/cm^2, at 40 K and at room temperature. Backscattering spectra of 1 MeV He^+ ions were measured in the same target chamber, a surface-barrier detector with 15 keV resolution recording He^+ ions backscattered at a 150° angle. These spectra and the trend of defectiveness buildup with increasing implantation dose reveal that this buildup proceeds in two stages at 40 K (number of defects first increases at same rate near unity with P^+ and Al^+ ions, but the cumulative number of defects remains always somewhat lower with Al^+ ions than with comparable dose of P^+ ions, then with $5 \cdot 10^{13}$ cm^{-2} ions of either kind the implantation layer becomes completely disordered) and in three stages at room temperature (number of defects first increases at different rates, slower with Al^+ ions up to $1 \cdot 10^{15}$ cm^{-2} than with P^+ ions up to $2 \cdot 10^{14}$ cm^{-2}, then very fast at almost same rate with Al^+ ions up to $4 \cdot 10^{15}$ cm^{-2} as with P^+ ions up to $3 \cdot 10^{14}$ cm^{-2}, when the implantation layer becomes completely disordered, then further still as the amorphized layer becomes thicker). Figures 2, references 16: 6 Russian, 10 Western.
[214-2415]

UDC 621.315.592

EFFECT OF ELECTRIC FIELD ON BUILDUP OF RADIATIVE DEFECTS IN GALLIUM ARSENIDE

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 5, May 82 (manuscript received 29 Jun 81, after final revision 18 Nov 81) pp 912-914

MAMONTOV, A. P. and PESHEV, V. V.

[Abstract] A study was made of the kinetics of radiative defects within the space-charge region and within the bulk of gallium arsenide irradiated by γ-quanta. Diode structures of this semiconductor were produced on epitaxial layers with carrier concentration of $(1-5)\cdot 10^{15}$ cm^{-3} on GaAs substrates with carrier concentration $(1-3)$. 10^{18} cm^{-3}, Schottky barriers then built in by deposition of titanium. The diodes were irradiated from a Co^{60} source with doses from $3.2\cdot 10^{16}$ to $2\cdot 10^{17}$ $quanta/cm^2$ at room temperature. The dependence of defect concentration on γ-quanta dose was measured by the method of nonstationary capacitive spectroscopy of deep levels. Measurements in the space charge region were made with a 40 V reverse bias voltage across the diode to ensure that $z \geq h_2$ (z- width of space-charge region from semiconductor surface to intersection of electronic Fermi quasi-level and valence band, h_2- width of space-charge region due to charge redistribution at deep levels). Measurements in the semiconductor bulk were made without bias voltage. The condition $h_2 \gg h_1$ (h_1 - width of space-charge region due to contact potential difference) was also satisfied during measurements. The results reveal that E2 and E3 centers build up at different rates: E2 centers faster in space-charge region than in bulk, E3 centers faster in bulk than in space-charge region, and E2 centers everywhere faster than E3 centers. Figures 2, references 4: 2 Russian, 2 Western.
[216-2415]

UDC 621.315.592

ION IMPLANTATION OF IMPURITIES IN n-$Hg_{0.8}Cd_{0.2}Te$, PART 1: GROUP-II IONS Mg^+, Zn^+, Cd^+

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 5, May 82 (manuscript received 20 Apr 81) pp 782-788

VODOP'YANOV, L. K., KOZYREV, S. P. and SPITSYN, A. V., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] An experimental study was made of ion implantation in n-$Hg_{0.8}Cd_{0.2}Te$ as means of producing planar semiconductor structures with controllable properties. The raw material was n-$Hg_{0.8}Cd_{0.2}Te$ wafers 1 mm thick with $E_g = 0.1$ eV

and $n < 10^{16}$ cm^{-3} at 85 K, mechanically treated and then etched in methanol solution of bromine. Ions of group-II elements (100 keV Mg^+, 300 keV Zn^+, 300 keV Cd^+) were implanted in them with a "High Voltage Engineering Europa" heavy-particle accelerator in doses ranging from $3 \cdot 10^{12}$ to $1 \cdot 10^{15}$ cm^{-3} at an ion current smaller than 0.30 $\mu A/cm^2$ so as to avoid heating of a crystal by more than 10°C. Group-II elements had been selected because isomorphic substitution does not result in formation of electrically active centers and because they form continuous solid solutions $Hg_{1-x}Zn_xTe$ and $Hg_{1-x}Cd_xTe$ respectively over the entire $0 \leq x \leq 1$ range. Physical properties of the subsurface implantation layer associated with free electrons were measured by infrared reflection spectroscopy, assuming Gaussian depthwise distribution of impurity ions. The results indicate a V-form dependence of carrier concentration on implantation dose, with the carrier concentration in the implantation layer first decreasing and then increasing to saturation as the implantation dose reaches $1 \cdot 10^{15}$ cm^{-3}. This trend is hypothetically attributed to "pinning" of the Fermi level by the resonance level of radiative defects within the conduction band. The properties of the implantation layer in n-$Hg_{0.8}Cd_{0.2}Te$ thus depend largely on radiative defects. Annealing was found to produce some quantitative changes. Figures 5, tables 2, references 16: 2 Russian, 14 Western.
[216-2415]

LIGHT-STIMULATED TRANSFORMATION OF MOLECULES: NEW KIND OF 'GIGANTIC' OPTICAL NONLINEARITY IN LIQUID CRYSTALS

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 82, No 5, May 82 (manuscript received 26 Nov 81) pp 1475-1484

ODULOV, S. G., REZNIKOV, Yu. A., SOSKIN, M. S. and KHIZHNYAK, A. I., Institute of Physics, UkSSR Academy of Sciences

[Abstract] A new anomalous "gigantic" cubic nonlinearity in nematic liquid crystals such as MBRA (p-methoxybenzylidene-p-butylaniline) is examined on the basis of diffraction by light-induced dynamic holographic gratings. Formation of such gratings on molecules transformed by light is analyzed theoretically, considering two coherent light beams of intensities I_1 and I_2 which intersect at angle 2θ so as to produce a resultant space distribution of intensity $I_0^{o,e}(x) = I_0^{o,e}(1 + m \cos\frac{2\pi x}{\Lambda}$ ($I_0 = I_1 + I_2$, $m = 2\sqrt{I_1 I_2}/(I_1 + I_2)$, period of diffraction grating $\Lambda = \lambda/2\sin\theta$, λ-wavelength, x-space coordinate, o- ordinary polarization, e- extraordinary polarization). Molecules transformed by photostimulation can either spontaneously transform to ordinary ones or diffuse anisotropically, both processes resulting in erasure of the refraction grating. An experiment was performed in recording holograms with light from He-Cd and Ar

lasers so as to cover the $\lambda = 0.44-0.488$ μm range of wavelengths. Measurements have revealed that the diffraction efficiency is proportional to the intensity (I_0) squared. It increases as the grating period increases, first at an increasing rate in the range of small periods and then at a decreasing rate toward saturation as the period becomes larger. The cubic nonlinearity index (ϵ_2, cm^3/erg) as well as the absorption coefficient (α, cm^{-1}) and the birefringence ($n_e - n_o$) are very large near the edge of intrinsic absorption ($\epsilon_2 \approx 5 \cdot 10^{-2}$ cm^3/erg at $\lambda = 0.44$ μm with $\Lambda = 13$ μm for MBBA) but decreases very fast as the wavelength increases. The authors thank I. P. Il'chishin and Ye. P. Sukhenko for helpful discussions and assistance. Figures 6, references 19: 15 Russian, 4 Western.
[225-2415]

UDC 532.783

STRUCTURAL ORDERING AND TRANSLUCENCE OF NEMATIC LIQUID CRYSTALS: EXPERIMENTALLY OBSERVED REORIENTATION OF MOLECULES IN LASER FIELD, LIGHT-INDUCED STABILIZATION OF FLUCTUATIONS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 5, May 82 (manuscript received 12 May 80, final edition received 9 Jun 81) pp 909-914

ARAKELYAN, S. M., ARUSHANYAN, L. Ye., GARIBYAN, O. V., GALSTYAN, S. R., TABIRYAN, N. V., and CHILINGARYAN, Yu. S., Yerevan State University

[Abstract] Effects of a laser field on nematic liquid crystals, namely reorientation of the molecular director with attendant improvement of structural ordering (light-induced translucence), are examined theoretically in terms of molecule kinetics and dynamics. These effects were observed directly in experiments with 50 μm thick layers of MBBA (p-methoxybenzylidene-p'-butylaniline) at room temperature in a linearly polarized low-intensity laser field. Scattering of light was measured as a function of time and of incident radiation power, from a few to several hundred kW/cm^2, from a helium-neon laser ($\lambda = 0.633$ μm) and an argon laser ($\lambda = 0.488$ μm) operating in the continuous mode. Translucence was found to increase monotonically with time to a stabilization level, the role of thermal processes increasing at higher power levels. After the low-power laser beam was "instantaneously " cut off crystals became turbid and returned to their original state with strong scattering of light. Similar reorientation in nematic liquid crystals was also observed in the field of a high-power (10 MW/cm^2) YAG:Nd^{3+} Q-switched laser and will be reported separately. The authors thank B. Ya. Zel'dovich and A. S. Karayan for discussion of problems and valuable comments. Figures 3, references 9: 7 Russian, 2 Western.
[219-2415]

ELECTRICITY AND MAGNETISM

DIGITAL-COMPUTER SIMULATION OF FILTRATION OF TWO-DIMENSIONAL SIGNAL FROM MULTIPLICATIVE INTERFERENCE

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: FIZIKA in Russian Vol 17, No 2, Mar-Apr 82 (manuscript received 15 May 81) pp 83-86

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[Abstract] The problem of nonlinear filtration of a two-dimensional signal from multiplicative interference due to a turbulent atmospheric layer, the mixture describable as $A(x,y) = A_0(x,y)e^{\chi(x,y)}$, can be solved by means of a space filter representing the two-dimensional analog of an optimum Wiener filter. Such a filter can be simulated on a digital computer with the algorithm of fast two-dimensional discrete Fourier transformation and inverse Fourier transformation. The procedure has been programmed on an M4030 computer, assuming both signal $A_0(x,y)$ and interference $\chi(x,y)$ to be real rather than complex, the latter having a normal distribution with $<\chi(x,y)> = 0$ and fully described by the correlation function $B_\chi(\rho) = <\chi^2> b_\chi(\rho)$ (ρ- distance between two points in the receiver aperture, $b_\chi(\rho)$ determined by refractive index distribution, thickness of turbulent layer L, and wavelength of radiation λ). Computations for a typical 0.3x0.3 m aperture and $\lambda L = 10^{-2}$ m^2 indicate that the algorithm is efficient, fast and accurate. Figure 1, references: 1 Russian.
[199-1862]

ELECTROMAGNETIC SHOCK WAVES IN MAGNETIZED VACUUM

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 82, No 5, May 82 (manuscript received 22 Oct 81) pp 1366-1374

ZHELEZNYAKOV, V. V. and FABRIKANT, A. L., Institute of Applied Physics, USSR Academy of Sciences

[Abstract] Equations are derived which describe the dynamics of weakly nonlinear electromagnetic waves propagating through magnetized vacuum, with a correction

term for radiation in the Lagrangian. Solution of these partial differential equations is feasible in the one-dimensional case, in which it yields nonlinearly coupled TE and TM modes propagating in the same direction within a small solid angle. Locking and interaction of these modes is impossible, because of their different phase velocities and polarizations, and only TE modes remain nonlinear. The evolution of simple TE waves involves formation of step discontinuities evolving into a shock wave, inasmuch as the high-frequency dispersion of low-order (long-wave) harmonics is negligible. Figures 2, references 7: 5 Russian, 2 Western.
[225-2415]

UDC 534.222

THEORY OF PARAMETRIC RECEIVER ANTENNA

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 23, No 3, May-Jun 82 (manuscript received 26 Dec 80) pp 60-63

DEVYATERIKOVA, Ye. A. and ZAREMBO, L. K., Chair of Acoustics, Moscow University

[Abstract] In a parametric receiver antenna for maritime applications the low-frequency acoustic signal interacts with a high-frequency reference signal. Assuming an axisymmetric wave beam, the two-dimensional nonlinear wave equation for the velocity potential in a heat conducting viscous medium is solved in the first approximation of a quasi-planar reference wave and then in the second approximation of a combination wave having the same transverse distribution as the reference wave. The radiation pattern of such an antenna in such a medium is calculated on this basis, with diffraction subsequently taken into account in the quasi-optical approximation. The results are applicable to optimization of the antenna design, which must also consider intrinsic noise due to a finite-width spectrum of the reference wave and interference due to sea noise interacting with the reference wave and its harmonics. The authors thank I. P. Chinchuzov for helpful suggestions. References 7: 4 Russian, 3 Western.
[222-2415]

UDC 537.533.331

BIPLANAR ELECTROSTATIC LENSES

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 5, May 82
(manuscript received 12 Mar 81) pp 945-949

AFANAS'YEV, V. P., Physico-Technical Institute imeni A. F. Ioffe, USSR
Academy of Sciences, Leningrad

[Abstract] Biplanar electrostatic lenses with two planes of symmetry parallel to each other and to the optical axis are considered as means of correcting spherical aberration. The three-dimensional distribution of electric potential in such a lens is calculated from its distribution in a transverse plane near the center, far from the edges, with geometrical symmetry and electrode "influence" functions taken into account for a typical single lens with three electrodes in each plane. The problem is generalized by disregarding field symmetry and seeking the solution to the appropriate Laplace equation. Biplanar lenses have very flexible electrically controllable optical properties, are highly technological and, unlike crossed lenses, do not require tedious adjustment of electrodes. They can be used for focusing with deflection, in which case there appears a sextupole regular field component needed for correcting aberrations. Figure 2, references 3: 1 Russian, 2 Western.
[219-2415]

UDC 553.9.12

FORMATION OF LARGE-APERTURE HIGH-CURRENT ELECTRON BEAMS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 5, May 82
(manuscript received 12 Jan 81, final edition received 4 Jun 81)
pp 929-934

ABDULLIN, E. N., KONOVALOV, I. N., LOSEV, V. F., TARASENKO, V. F. and
CHESNOKOV, S. M., Institute of High-Current Electronics, USSR Academy of
Sciences, Tomsk

[Abstract] Vacuum diodes for electron accelerators have been designed which form ribbon-like electron beams for excitation of gas lasers. Dimensions and spacing of the two cylindrical electrostatically focusing electrodes were calculated to ensure sufficient width of a parallel or tapering electron beam with minimum electric field intensity at their surface, roughly in accordance with the 3/2-power law for flat diodes. The number of cylindrical emitter elements is sufficiently small to minimize mutual shielding, their dimensions

and spacing calculated to ensure uniform beam current density within a well defined cross section. There is no severe requirement here regarding stability of the beam current, inasmuch as the duration of beam pulses for pumping a gas laser need not exceed 10 μs. Actual dimensions of two such diodes are given one diode forming a 19(13)x140 cm 300 keV - 1 A/cm^2 electron beam for CO$_2$ las lasers and one diode forming a 10x140 cm 300 keV - 8 A/cm^2 electron beam for XeCl lasers. These diodes were tested, voltage and current transients were measured, beam traces were recorded on photographic film. The diode impedance remains constant during the entire beam pulse period, which facilitates efficient energy transfer from tank circuit to beam. The authors thank S. A. Belomyttsev for performing the numerical calculations. Figures 4, references 6: 5 Russian, 1 Western.
[219-2415]

UDC 517.958:532.59

ASYMPTOTIC BEHAVIOR OF SOLUTION TO PROBLEM IN THEORY OF WAVES ON SURFACE OF THIN STRATIFIED FLUID LAYER

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 22, No 3, May-Jun (manuscript received 3 Jun 80) pp 690-699

VARLAMOV, V. V. and GABOV, S. A., Moscow

[Abstract] The problem of linear waves on the surface of an infinitely large plane layer of stratified fluid is solved with consideration of the earth's curvature in the vicinity of the equator. The asymptotic behavior of the Green's function is examined in the case of a layer thickness much smaller than the radius of curvature. The corresponding equation of motion for small oscillations is split into two, according to the Boussinesq approximation, so as to eliminate compressibility and acoustic waves with the density of the fluid not constant except along the trajectory of a particle. These equations are supplemented with an Euler equation. An auxiliary eigenvalue problem is solved by separation of variables, with aid of three lemmas and a basis system of eigenfunctions. The original boundary-value problem is then reduced to a double integral of the Green's function. The asymptotic behavior of the latter is established on the basis of two theorems pertaining to "local" and "integral" estimates of the function. The authors thank A. G. Sveshnikov and I. A. Shishmarev for helpful suggestions. References: 5 Russian.
[213-2415]

UDC 551.465

STEADY-STATE CIRCULATION IN SHALLOW SEA WATER

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 23, No 3, May-Jun 82 (manuscript received 10 Jul 79, final edition received 26 Oct 81) pp 66-69

SHEIKOVNIKOV, N. K., NOVOCHINSKIY, S. M. and RAKITINA, I. S., Chair of Physics of Sea and Inland Water, Moscow University

[Abstract] A model study was made to determine, under laboratory conditions, the flow pattern in shallow sea water in shelf regions during wind-induced tides. Experiments were performed in a 14 m long aerohydrodynamic channel with a 2.5x1.23 m cross section. The water level was 0.3 m above the bottom and a 0.35 m long wedge fitting into the channel simulated a sloping shore. Wind was produced along the channel with a velocity of 8.1 m/s at an altitude of 0.3 m above the still water surface and with a vertical velocity profile logarithmic up to 0.7 m above the water level. Vertical profiles of mean velocity in the drift-flow zone (upper layer) and in the gradient-counterflow zone (lower layer) as well as fluctuations of longitudinal and vertical velocity components in the gradient zone, also wave parameters at the surface, were measured at various distances from the water edge on the shelf. Figures 3, references: 2 Russian.
[222-2415]

UDC 539.122.18

USE OF FREE ELECTRON LASER FOR PRODUCING OPPOSED HIGH-ENERGY PHOTON BEAMS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 264, No 4, Jun 82
(manuscript received 25 Jan 82) pp 849-852

KONDRATENKO, A. M., PAKHTUSOVA, Ye. V. and SALDIN, Ye. L., Institute of Nuclear Physics, Siberian Department, USSR Academy of Sciences, Novosibirsk

[Abstract] A scheme is proposed for producing opposed photon beams solely on the basis of accelerator technique without external light source. Electrons of a relativistic electron beam in an open undulator are made to interact through radiation fields so as to cause instability of certain harmonics of the electron concentration distribution, which results in electron bunching and in coherent radiation used for producing a dense light cluster. A typical device for this purpose includes an injector, an accelerator-discriminator, a high-frequency oscillator, and an undulator. The same electron beam is used for generation of coherent radiation and conversion to high-energy photons at various acceleration stages, which automatically solves the problems of phasing and bunch length optimization as well as the problem of required repetition rate. Its performance is calculated on basis of theoretical relations and numerical data for a relativistic cylindrical electron beam moving through a spiral undulator. With a sufficiently long undulator, shot noise in an electron bunch can serve as initial excitation for buildup of radiation instability. The authors thank Ya. S. Derbenev for his discussions, A. N. Skrinskiy for his interest in this study, also G. L. Kotkin, V. G. Serbo and V. I. Tel'nova for their comments. Article presented by Academician A. N. Skrinskiy 15 Jan 82. Figure 1, references 9: 6 Russian, 3 Western.
[211-2415]

FREE-ELECTRON MASERS WITH BRAGG RESONATORS

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 35, No 10, 20 May 82 (manuscript received 20 Apr 82) pp 418-420

BOTVINNIK, I. Ye., BRATMAN, V. L., VOLKOV, A. B., GINZBURG, N. S., DENISOV, G. G., KOL'CHURGIN, B. D., OFITSEROV, M. M. and PETELIN, M. I., Institute of Applied Physics, USSR Academy of Sciences

[Abstract] An electrodynamic system for a maser has been designed according to a nonlinear theory which should simultaneously satisfy the two requirements of selective mode excitation and transportability of high-intensity electron flux, With proper improvement of the active medium, the parameters of the accelerator and of the electron-optical system were modified for operation either as ubitron with free electrons oscillating at bounce frequency or as maser at cyclotron autoresonance with high efficiency and low sensitivity to initial spread of electron velocities. The electron beam is 6 mm in diameter, it carries electrons of 350-600 keV energy in a current of 0.4-1.0 kA and 100 ns pulse duration. The initial spread of transverse velocities of electrons and of radii of driving centers is reduced by use of a double cathode in the magnetic field as large here as in the interaction space. A magnetic field modulated in space with a period of 2 cm pumps oscillation energy into the electron beam. The resonator is a waveguide segment with circular cross section and with two Bragg mirrors, two corrugated segments and a smooth one separating them. In an experiment with the device operating as autoresonance-cyclotron maser and as ubitron it was possible to achieve single-mode emission in the $H_{1,1}$ mode at the 4.3 mm wavelength, with a power output of 6 MW at 4% efficiency and 2 MW at 1% efficiency respectively. The duration of emission pulses was 5-30 ns, the frequency conversion ratio was 3-4 and 5 respectively. The authors thank V. I. Belousov, A. V. Gaponov-Grekhov and A. Sh. Fiks for helpful discussions. Figures 2, references 11: 6 Russian, 5 Western.
[208-2415]

VARIABLE-BAND SEMICONDUCTOR LASER WITH OPTICAL PUMPING

Yerevan IZVESTIYA AKADEMII NAUK ARMYANSKOY SSR: FIZIKA in Russian Vol 17, No 2, Mar-Apr 82 (manuscript received 15 Jun 80) pp 87-90

MURADYAN, A. M., Yerevan Polytechnic Institute imeni Karl Marx, and PETROSYAN, S. G., Yerevan State University

[Abstract] A laser with optical pumping for population inversion is described whose active medium consists of a uniform-band semiconductor region between two variable-band semiconductor regions with linearly increasing widths on both

sides. The threshold pumping power is calculated, assuming a Gaussian distribution of pump energy about some center frequency $\omega_c > E_{g,act}/\hbar$ and using an experimentally established dependence of optical gain on semiconductor and dopant characteristics. For a typical p-$Ga_xAl_{1-x}As/GaAs/Ga_xAl_{1-x}As$ structure it is found to be much lower than for a plain uniform-band active medium. When pumped with another laser, such a variband structure becomes an efficient converter of one coherent radiation to another. The authors thank V. M. Arutyunyan and R. A. Siris for discussing this study. Figure 1; references 8: 6 Russian, 2 Western.
[199-2415]

UDC 621.315.592

TEMPERATURE DEPENDENCE OF EMISSION THRESHOLDS OF DOUBLE HETEROSTRUCTURE InGaAsP/InP LASERS (WAVELENGTH 1.55 μm) WITH OPTICAL AND CURRENT EXCITATION OF EXCESS CARRIERS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 5, May 82 (manuscript received 9 Oct 81) pp 848-851

GARBUZOV, D. Z., CHALYY, V. P., MISHURNYY, V. A., AKHMEDOV, D., AGAYEV, V. V. and YEVTIKHIYEV, V. P., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] The temperature dependence of emission thresholds of double heterostructure InGaAsP/InP lasers (wavelength 1.5 μm) with either current (injection) excitation or optical excitation of excess carriers in the active region was measured on structures consisting of four layers (n-InP buffer layer, $In_{0.56}Ga_{0.44}As_{0.93}P_{0.07}$ active layer, $In_{0.78}Ga_{0.22}As_{0.5}P_{0.5}$ buffer layer, $In_{0.78}Ga_{0.22}As_{0.5}P_{0.5}+0.2\cdot10^{-3}$ at.% Zn buffer layer) deposited on n-InP substrates by the liquid-phase epitaxial process, with second and third layers intentionally not doped and with the p-n junction shifted relative to the boundary between third and fourth layer toward the active one. The threshold current density in the case of current excitation was measured with laser diodes in the pulse mode (300-500 μm long resonator cavity, (Zn,Au) + Ag contact tabs on p-region, (Te,Au)+Ag contact tabs on n-region deposited and brazed in). Optical excitation was effected by means of a single-mode YAG:Nd^{3+} laser (wavelength 1.06 μm) operating in the pulse mode with Q-switching. Spectra of threshold emission and also spectra of spontaneous emission were recorded for each mode of excitation. The thresholds were found to rise linearly with temperature, at a faster rate in the case of current (injection) excitation because of additional losses which also increase with higher

temperature. The authors thank A. T. Gorelenko and Ye. L. Portnoy for valuable consultations and discussions, S. G. Konnikov and V. M. Zheludev for performing x-ray microspectral measurements, also Zh. I. Alfërov for formulating the problem and taking interest in this study. Figures 2, table 1, references 10: 4 Russian, 6 Western.
[216-2415]

UDC 621.315.592

INFLUENCE OF RE-RADIATION EFFECTS ON THRESHOLD CHARACTERISTICS OF DOUBLE HETEROSTRUCTURE InGaAsP/InP LASERS WITH OPTICAL PUMPING

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 5, May 82 (manuscript received 9 Oct 81) pp 844-847

GARBUZOV, D. Z., CHALYY, V. P., GORELENOK, A. T., AGAYEV, V. V. and MDIVANI, V. N., Phvsico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] Effects of re-radiation on the threshold characteristics of double heterostructure InGaAsP lasers (wavelength 1.3 μm) with optical pumping were studied on n-n-n structures consisting of an n-InP buffer layer, a μm thick $In_{0.7}Ga_{0.3}As_{0.64}P_{0.36}$ active region, and an InP upper layer. Excess carriers in the active region were excited by means of a continuously pumped YAG:Nd^{3+} laser (wavelength 1.06 μm) emitting pulses of 100 ns duration at a repetition rate of 2 kHz. Emission spectra of the double heterostructures were measured with and without an absorbing germanium layer on the InP surface. The data indicate that such an absorption layer raises the threshold pumping power, to levels up to twice as high at room temperature and less at higher temperature. Metal (nickel) layers serving as contact tabs have a similar effect, but to a lesser degree and not as consistent. The authors thank V. I. Skopin for depositing germanium layers, V. A. Mishurnyy and D. Akhmedov for supplying double p-n heterostructure-InGaAsP specimens, also Zh.I.Alfërov for helpful discussions. Figures 2, tables 2, references: 5 Russian.
[216-2415]

CW GROWN-MESASTRIP InGaAsP/InP HETEROSTRUCTURE LASERS PRODUCED BY COMBINATION LIQUID-PHASE AND GASEOUS-PHASE EPITAXY

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 11, 12 Jun 82 (manuscript received 3 Mar 82) pp 680-684

ALFEROV, Zh. I., VASIL'YEV, M. G., GOLIKOVA, Ye. V., GORELENOK, A. T., DURAYEV, V. P., IVANYUTIN, L. A., IL'INSKAYA, N. D., SINITSYNA, G. M., TARASOV, I. S., USIKOV, A. S., TSYPLENKOV, I. N. and SHVEYKIN, V. I., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] A hybrid technology has been developed for producing cw InGaAsP/InP lasers for use with fiber-optics communication lines, a reverse biased p-n junction in i-InP mesatrip providing the necessary optical and current limitation. The binary InGaAsP heterostructure is grown by liquid-phase epitaxy on n(p)-InP<Sn(Zn)>[100] substrate, the InP<Cr>mesastrip was grown by the chloride-hydride method of gas-phase epitaxy, and two contact tabs (one Au-Zn, one Au-Te) are vacuum deposited after removal of the SiO_2 mask. Specimens with up to 300 μm long Fabry-Perot resonators were sliced off and mounted through indium on copper heat sinks, for measurement of radiation spectrum, threshold current and its temperature dependence, power-current characteristic, also intensity distribution in the far field, under pulse and constant-current excitation. Misalignment of lattice parameters, as determined from the spectral dependence of linear polarization of spontaneous electroluminescence, was found to be within ±0.05%. The threshold current at 285 K for a 5 μm wide mesastrip and a 250 μm long resonator was 110 mA under constant-current excitation and 150 mA under excitation by pulses of 1 μs duration at a 1 kHz repetition rate. Figures 3, references 9: 5 Russian, 4 Western.
[227-2415]

SMALL CO_2 LASER WITH SEALED ELECTRON SOURCE

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 11, 12 Jun 82 (manuscript received 22 Sep 81, final edition received 4 Apr 82) pp 644-648

BYCHKOV, Yu. I., KURBATOV, Yu. A., MESYATS, G. A., ORLOVSKIY, V. M. and OSIPOV, V. V., Institute of High-Current Electronics, Siberian Department, USSR Academy of Sciences, Tomsk

[Abstract] It is possible to reduce weight and size of CO_2 pulse lasers with electrical ionization by use of sealed diodes for generating short-duration electron beams as external ionization source. A small prototype MIG-1 of such a laser has been built with standard MIRA-ZD X-ray equipment. The active zone

measures 0.6x1.5x6 cm and contains a $CO_2:N_2$ = 1:1 gas mixture under pressure of 1-6 atm. The resonator is formed by a spherical gold mirror (radius of curvature 10 m, reflection coefficient 100%) and a plane germanium mirror with tellurium coating (reflection coefficient 80%). The electron beam was designed on basis of the equilibrium equation for electrons in the ionization-recombination model, namely $t_n = 1.47/\sqrt{\beta\psi}$ ($\beta = 10^{-6} - 10^{-7}$ recombination factor, $\psi = jn/eN_0p\langle\sigma\rangle$, jn-current density, e- electron charge, p- pressure of gas mixture, N_0- concentration of particles under pressure p= 1 atm, $\langle\sigma\rangle$ average cross section for ionization of gas by fast electrons. Typically, p= 6 atm and jn= 28 A/cm^2 yield t_n = 4.2-13.6 ns. Calculated performance characteristics, energy input to gas mixture and energy output from laser as functions of ratio E/p (E- electric field intensity, p- pressure) indicate the feasibility of maximizing the energy output with a 10 cm^3 active zone under p= 3 atm and attaining an efficiency of 5% at a pulse repetition rate of 4 Hz. Figures 2, references 8: 7 Russian, 1 Western.
[227-2415]

SPIN MODES OF SUBLIMATION OF SOLID UNDER LASER RADIATION

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 82, No 5, May 82 (manuscript received 5 Nov 81) pp 1604-1606

ANISIMOV, S. I., GOL'BERG, S. M. and TRIBEL'SKIY, M. I., Institute of Theoretical Physics imeni L. D. Landau, USSR Academy of Sciences

[Abstract] sublimation of solids under laser radiation is considered in terms of surface evaporation of condensate and kinetics of phase-transition front in a temperature field describable by the equation of heat conduction with appropriate boundary conditions. The three-dimensional problem can, without loss of essential characteristics, be reduced to the two-dimensional one of a thin hollow cylinder coaxial with a laser beam and solved by numerical methods. Calculations reveal a behavior varying with the radiation intensity. At radiation intensities not much above threshold level the initial additive cluster of many modes of approximately equal amplitudes evolves into a quasi-steady evaporation wave with curvilinear front and with a fundamental period corresponding to the maximum linear instability increment. At radiation intensities sufficiently high above threshold level the range of positive instability increments becomes so wide as to encompass harmonics of the initial perturbation with a resulting unsteady evaporation wave. As the radiation intensity increases beyond the critical level, there appear vibrational and spin modes until the temperature field becomes stochastic. An analogous pattern is known

in the theory of combustion. The authors thank V. K. Gryaznov for assisting in numerical calculations and B. A. Malomed for helpful discussions, also E. N. Sobol' for referring to article by W. W. Duley and W. A. Young in JOURNAL OF APPLIED PHYSICS Vol 44, 1973 p 4236. Figures 2, references 8: 7 Russian, 1 Western.
[225-2415]

UDC 621.373.826:53

BREAKDOWN OF AIR BY LASER RADIATION AT $\lambda \sim 10$ μm WAVELENGTH

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 5, May 82
(manuscript received 11 Jun 81) pp 901-903

GRIGOR'YEV, F. V., KALINOVSKIY, V. V., KORMER, S. B., LAVROV, L. M. and MISHUCHKOV, G. A.

[Abstract] An experimental study was made pertaining to breakdown of air by laser radiation and, particularly, effect of self-focusing on the threshold radiation intensity. Laboratory air was irradiated by 100-200 nanosecond pulses from a DF-CO_2 chemical laser with pumping from a xenon lamp, at the single wavelength $\lambda = 9.55$ μm (most intense) extracted from the spectrum, with beam divergence within $(6-8)\cdot 10^{-4}$ rad and power increased up to 250 MW. The focal volume was a cylinder of diameter $d= f\theta$ and length $L = (\sqrt{2}- 1)f^2\theta/(D-f\theta)$ equal to the length of the caustic (f- focal length of spherical mirror, θ- divergence of laser beam, D- diameter of laser beam at entrance to focusing system). The results indicate that the threshold power density of laser radiation causing breakdown decreases with increasing focal volume (length of caustic) until it reaches the threshold $q= (1-3)\cdot 10^8$ W/cm^2 for thermal breakdown of aerosol and dust, after which it remains almost constant at this level as the focal volume increases further beyond 0.5 cm^3. When the breakdown threshold is governed by thermal breakdown of particles in suspension, the average threshold radiation intensity varies with the focal volume according to the empirical relation $\langle I_{thr}\rangle = (3-10)\cdot 10^9(2/Vn)^{1/(\beta- 1)}$W/cm^2 (V- focal volume, $n = 10^5-10^6$ cm^{-3} concentration of atmospheric aerosol, $\beta = 5$ factor characterizing the size distribution of aerosol). Figures 2, references 5: 2 Russian, 3 Western.
[219-2415]

HEATING OF LASER DIODES

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 12, 26 Jun 82 (manuscript received 24 Mar 82) pp 750-754

KONONENKO, V. K. and PAK, G. T., Institute of Physics, BSSR Academy of Sciences, Minsk

[Abstract] Heating of a laser diode and the activation energy for defect formation during its gradual degradation can be estimated, for reliability analysis, on basis of calculated power dissipation and known thermal parameters of the heterostructure layers. The characteristic activation parameter needed for such an estimate depends on the conditions of diode testing, usually accelerated testing, and on the method of measurement so that it can only serve as indicator of sensitivity of degradation processes to temperature changes. In the case of testing at fixed ambient temperature the degradation rate γ depends on the thermal resistance of the diode R_T and on the temperature of the active region, which yields an exponential (Arrhenius-law)relation. The degradation rate can be taken as the rate at which the pumping power (current) at the emission threshold increases with time. The activation parameter is, accordingly, determined from the slope of the almost straight line representing the $\gamma(R_T)$ relation in semilog coordinates. The diode life is then determined upon extrapolation of the degradation rate to the operating temperature. The degradation rate is also proportional to the probability of defect formation and to the square of the concentration of injected electrons, both depending on the temperature, with the constant of nonoptical transition as proportionality factor. Typical calculations are shown for a GaAs heterostructure with the difference between acceptor and donor concentrations in the active region normalized to $N_0 = 10^{18}$ cm^{-3}. Figure 1, references 10: 5 Russian, 5 Western. [228-2415]

STOCHASTIC MODE OF TITANIUM HEATING BY LASER RADIATION

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 12, 26 Jun 82 (manuscript received 22 Feb 82) pp 744-747

BUZYKIN, O. G. and BURMISTROV, A. V.

[Abstract] Experiments performed by other authors (V. A. Bobyrev, F. V. Bunkin, N. A. Kirichenko, B. S. Luk'yanchuk and A. V. Simakin, PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI Vol 32, 1980 p 608) with heating of titanium specimens by continuous sharply focused laser radiation have revealed complex stochastic fluctuations of the heating rate. The original hypothesis of a "strange attractor" heating mode produced by surface oxidation and thermal conductivity effects is here discarded in favor of another hypothesis, namely that

melting (which does not occur during heating by uniformly distributed laser radiation) causes such fluctuations. This hypothesis is supported by numerical solution of the equation of heat conduction for a symmetric cylindrical specimen for appropriate boundary conditions at the surface, taking into account radiative and convective losses and not only melting but also recrystallization. The presence of respective phase transition fronts has been included through solution of the Stefan problem and the TiO_2 film has been assumed to build up exponentially. The hypothesis can be verified experimentally by the method of transient heating. The possibility is allowed that changes in the absorption capacity of titanium oxide can also contribute to those fluctuations. Figures 1, References: 11 Russian.
[228-2415]

HETEROLASER WITH DISTRIBUTED FEEDBACK PRODUCED BY INTERFERENCE LASER IGNITION

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 13, 12 Jul 82 (manuscript received 19 Apr 82) pp 769-772

ALFEROV, Zh. I., KALANDARISHVILI, K. G., KOVAL'CHUK, Yu. V., PORTNOY, Ye. L. and SMIRNITSKIY, V. B., Physicotechnical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] A report on experimental realization of heterolasers with distributed feedback produced by interference laser ignition of epitaxial layers of heterostructures InGaAsP/InP. The width of the forbidden band of the quaternary compound was 1.08 eV. The output of a Q-switched neodymium glass laser on a wavelength of 1.06 μm with pulse duration of about 60 ns was split into two coherent beams interfering on the surface of the semiconductor material. The spatial frequency of the interference pattern was controlled by the angle at which the interfering beams came together. This frequency was selected from the condition of distributed feedback in fourth order of interaction of the waveguide mode with periodic optical inhomogeneity. The energy density of laser radiation was 0.7 J/cm^2, which was sufficient to change the luminescence properties of the specimen at antinodes of the interference pattern without damaging its surface. Specimens were studied at 95 K under conditions of pumping by an LGI-40 xenon laser with output focused in strips perpendicular to the grating lines. Lasing lines identified with the proposed heterolaser corresponded to modes with index of refraction $N_m = \frac{\lambda}{\alpha} \pm \sin \alpha_m$, where α_m is the angle of radiation output through the corrugated surface of a waveguide with corrugation spacing α. The identified lines were a shortwave line with λ = 1.1556 μm corresponding to mode $N_2 = 3.341$, and a long-wave line with λ = 1.1616 μm corresponding to the hybrid mode $N_{1,2} = 3.358$. Results show that Bragg

lines arise on the long-wave section of the amplification band. Lasers of this type should be useful in microelectronics for producing hybrid integrated circuits that contain electronic and optical components. Figures 2, references: 4 Russian.
[240-6610]

FEASIBILITY OF EXCIMER LASERS WITH IONIZATION BY NUCLEAR REACTOR RADIATION

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 13,, 12 Jul 82 (manuscript received 9 Apr 82) pp 789-791

BATYRBEKOV, G. A., KOSTRITSA, S. A., KUZ'MIN, Yu. Ye., TLEUZHANOV, A. B. and KHASENOV, M. U., Institute of Nuclear Physics, KaSSR Academy of Sciences, Alma-Ata

[Abstract] Research is done on diagnosing the plasma produced in the emission field of a steady-state nuclear reactor in laser mixtures ^{3}He + Xe + NF_3 and ^{3}He + Xe + CCl_4. The concentration of charge carriers was determined from current-voltage characteristics of a steady-state semi-self-maintained discharge. The experiments were done on a VVR-K reactor in the thermal neutron flux density range of 10^{10}-10^{14} n/cm^{2}s. The discharge chamber contained two coaxial cylindrical electrodes 102 and 140 mm in diameter and 100 mm long. Analysis of electron concentration as a function of neutron flux shows that for fluxes of thermal neutrons of about 10^{12} n/cm^{2}s or more, ion concentration is more than 10^{10} cm^{-3}, and electron concentration is more than 10^8 cm^{-3}. Figures 2, references 8: 6 Russian, 2 Western.
[240-6610]

CONTINUOUS LASING IN INJECTION LASER WITH RING CAVITY

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 13, 12 Jul 82 (manuscript received 18 Mar 82) pp 799-803

BOGATOV, A. P., YELISEYEV, P. G., OKHOTNIKOV, O. G., PAK, G. T., RAKHVAL'SKIY, M. P. and KHAYRETDINOV, K. A., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Experiments are done to determine conditions for getting single-frequency cw lasing in a ring cavity where coupling between opposed waves is minimized. The active elements studied were AlGaAs heterolasers with optical region about 0.2 μm thick and strip contact width of about 10 μm. The ring

cavity was formed by objective lenses, two opaque aluminum mirrors, a flat reflective diffraction grating with 600 lines/mm and a Fabry-Perot etalon. The path was closed for first-order diffraction, and the output was produced by the zero-order and second-order diffractions of the beams. An FD24K photocell was used for measuring the power of waves propagating in both directions in the cavity. The spectrum was observed by an MDR-4 monochromator. The spectrum showed simultaneous excitation of about 20 longitudinal modes of the ring cavity. Insertion of the Fabry-Perot etalon makes the output single-frequency. The proposed arrangement minimizes coupling between opposed waves. A mode close to traveling-wave operation is observed at a luminous flux density of about $2 \cdot 10^5$ W/cm^2. Further studies should be done with a nonreciprocal device that will enable spectral splitting between the opposed waves. Figures 2, references: 2 Russian.
[240-6610]

OPTICS AND SPECTROSCOPY

UDC 535.396

SCINTILLATION CHARACTERISTICS OF GADOLINUM-BEARING PHOSPHATE GLASSES

Leningrad FIZIKA I KHIMIYA STREKLA in Russian Vol 8, No 3, May-Jun 82 (manuscript received 3 Jun 81) pp 345-347

PALVANOV, V. P., VIKTOROV, L. V., SLEPUKHIN, V. K., SHUL'GIN, B. V. and SHTIN, A. P., Ural Polytechnic Institute imeni S. M. Kirov and Institute of Chemistry; Ural Science Center, USSR Academy of Sciences, Sverdlovsk

[Abstract] Feasibility of building scintillators with gadolinum-bearing phosphate glasses was studied, operation in the current mode being more convenient for circuit design and measurements than operation in the counting mode. Phosphate glasses of compositions $K_2O.(1-x)Y_2O_3.4P_2O_5.xGd_2O_3$ $(0 \leq x \leq 1)$ close to that of crystalline binary phosphates of rare-earth elements were tested, all four glasses (x= 0.1, 0.3, 0.5, 1) remaining colorless. Their radioluminescence spectrum falls within the ultraviolet range and does not depend on the gadolinum content; but the intensity peaks when x= 0.3 (5 mol.% Gd_2O_3). The spectral content of α-scintillation is identical to that of X- and photoluminescence, with characteristics typical of compounds with Cd^{3+} ions. The temperature dependence of scintillations was measured in a special-purpose cryostat by the one-photon autocorrelation method. Photoluminescence spectra were measured with an MDR-2 monochromator by the photoelectric method. The glasses were found to have a high scintillation yield, up to 9% relative to CsI-Tl, and a high chemical stability. They are nonhygroscopic and suitable for miniature radiation detectors over the 0.01-10 MeV energy range. Figures 2, table 1, references: 5 Russian.
[224-2415]

UDC 519.6:537.812

SET OF STANDARD PROGRAMS FOR SOLUTION OF PROBLEMS IN NONLINEAR OPTICS

Moscow ZHURNAL VYCHISLITEL'NOY MATEMATIKI I MATEMATICHESKOY FIZIKI in Russian Vol 22, No 3, May-Jun 82 (manuscript received 1 Jul 80) pp 756-758

AMOSOV, A. A., BORISOV, A. B., VALEDINSKIY, V. D., VLADIMIROV, M. V., SHILEYKIN, Ya. M., ZLOTNIK, A. A. and KUZ'MINA, M. A., Moscow

[Abstract] A set of standard programs has been compiled at the Scientific Research Computer Center of Moscow State University for solving problems in nonlinear optics. There are two groups of programs here, one for numerical calculations pertaining to propagation of light beams through nonlinear media and one for numerical calculations pertaining to nonlinear interaction of three light waves coming from different directions. The basis is the fundamental equation of propagation of electromagnetic waves through a nonlinear medium $\Delta v + k^2 v = f(|v|^2)v$, which, after extraction of the slow part of the solution, is replaced with its "parabolic" approximation. The programs include difference schemes ND1F1-4,5,7-9 and fast Fourier transformation FFT. The problem of wave interaction is solved by a finite-difference scheme, with a SERV1 program of most convenient data presentation. Another program PG facilitates the design of quantum-electronic devices with distributed feedback. All programs are written in FORTRAN for BESM-6 and YeS (Unified System) computers. References 14: 13 Russian, 1 Western.
[213-2415]

UDC 534.6

DYNAMIC CHARACTERISTICS OF ADAPTIVE MIRROR

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 23, No 3, May-Jun 82 (manuscript received 15 Jun 81) pp 83-85

PRUIDZE, D. V. and RENDEL', Yu. S., Chair of General Physics and Wave Processes, Moscow University

[Abstract] A controllable optical mirror is described which consists of two solid piezoceramic disks, one of them having a polished surface with an aluminum coating which serves both as mirror and electrode. The disks are bonded together so that their polarizations coincide and a control voltage applied to the inner electrode (the two outer electrodes grounded), through a hole in one disk, causes the plane structure to bend into a spherical one

with the diameter of one disk increasing and the diameter of the other one decreasing. The curvature of this mirror is controlled by the magnitude of the voltage. The dynamic characteristic of such a mirror, namely dependence of the vibration amplitude at its center on the frequency of the control voltage, was measured over the 0.05-20 kHz range with an interferometer. A noise generator was used for excitation, its output voltage adjusted to ensure an rms displacement of the mirror not larger than a quarter wavelength of light and thus a linear relation between mirror displacement and interferometer signal. The electric signal from the interferometer was preamplified for both recording and spectral analysis. The interferometer included a light beam splitter with full compensation of losses and two photoreceivers, with provisions for formation of an auxiliary interference pattern next to the main one on the second photoreceiver. Figures 3, references 3: 2 Russian, 1 Western. [222-2415]

UDC 535.417

SPECIAL EFFECTS INVOLVED IN RECORDING AND INTERPRETING SPECKLE INTERFEROGRAMS OF SHIFTING OBJECTS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 5, May 82 (manuscript received 19 Jul 80, final edition received 8 Dec 80) pp 896-900

KLIMENKO, I. S. and RYABUKHO, V. P., Moscow Physico-Technical Institute, Dolgoprudnyy, Moscow Oblast

[Abstract] New features of speckle interferogram recording have been discovered in an experimental study pertaining to double exposure of speckle photographs of shifting objects. In the case of objects shifting longitudinally in direction of the lens axis the contrast of speckle interferograms subsequently produced by space filtration and illumination with a collimated laser beam was found to depend largely on the aperture of the optical system, It increases from zero at fully open lens to magnitudes of the order of 0.5 as the lens closes, and with it the aperture angle decreases, becoming smaller with increasing displacement of the object. This effect is attributable to objectivity of speckle patterns recorded when object shifts during second exposure, with the conditions of "correlation" no longer prevailing. A decrease of the aperture results in an increase of the focusing depth and thus also of the critical distance at which the recorded field still retains subjectivity. The problem of decreasing aperture angle can be solved by use of an annular aperture with large outside diameter. In the case of transverse shifting of the object, the displacement consisting of a uniform component (parallel transfer) and a nonuniform component (rotation of object in its own plane), sufficient information is obtained by illumination of speckle photographs with an undivided

laser beam at several characteristic spots. The authors thank Yu. V. Bezzubov for assisting with the experiments. Figures 3, references 8: 4 Russian, 4 Western.
[219-2415]

CONVERSION OF SMOOTHLY TUNABLE RADIATION TO NEAR AND MIDDLE INFRARED BY MEANS OF STIMULATED RAMAN SCATTERING

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 12, 26 Jun 82 (manuscript received 21 Jan 82) pp 740-743

APANASEVICH, P. A., BATISHCHE, S. A., GANZHA, V. A., GRABCHIKOV, A. S., KAMACH, Yu. E., KOZLOVSKIY, Ye. N., MALEVICH, N. A., MOSTOVNIKOV, V. A., OVCHINNIKOV, V. M. and ORLOVICH, V. A., Institute of Physics, BSSR Academy of Sciences, Minsk

[Abstract] An experimental study was made to produce radiation smoothly tunable over the $\lambda = 1.03-8.11$ μm range by conversion of radiation from dye lasers to the second Stokes component of stimulated Raman scattering in compressed hydrogen. A dye laser was operated in three modes: first with a spectrum 2.2 cm^{-1} wide produced with a Fabry-Perot etalon and a 1200 lines/mm diffraction grating in the resonator cavity, next with the spectrum narrowed down to 9 cm^{-1} with only the diffraction grating in the resonator cavity, then with the spectrum narrowed down to 200 cm^{-1} with no tuning device in the resonator cavity. The radiation was focused through a lens (focal length 100 cm) onto the center of a cell containing gaseous hydrogen under a pressure of 40 atm. The second Stokes component was extracted by means of interference-type filters or a prism-type monochromator. The energy was measured with a photoreceiver and a conversion efficiency was calculated as a function of pumping radiation energy for various line widths. Conversion to the second Stokes component was found to be 5-7 times more efficient than conversion to the first component and was nearly independent of a change of the latter from 2.2 to 200 cm^{-1} resulting in a decrease of conversion efficiency by a factor of 2.12 only. This is only slightly worse than the decrease by a factor of 1.36 in the case of conversion to the first Stokes component. The frequency conversion by means of stimulated Raman scattering was further optimized by better focusing of the pumping radiation onto the cell and by suppression of all attendant (at least four) anti-Stokes components. Figure 1, table 1, references 7: 6 Russian, 1 Western.
[228-2415]

CHARACTERISTICS OF MANDEL'SHTAM-BRILLOUIN MIRROR WITH NANOSECOND DRIVING PULSE

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 12, 26 Jun 82 (manuscript received 6 Apr 82) pp 735-740

GALAGAN, B. I., GOL'BERG, S. M., MATYUSHIN, G. A., PODGAYETSKIY, V. M. and TRIBEL'SKIY, M. I., Scientific Research Institute of Organic Semi-Products and Dyes

[Abstract] Characteristics of a nonlinear Mandel'shtam-Brillouin mirror with a nanosecond driving pulse are analyzed from the standpoint of general application of such a device as means for shortening the duration and increasing the contrast of laser pulses. The system of three equations describing Mandel'shtam-Brillouin stimulated scattering in any medium, gaseous or other, are formulated in the approximation of plane waves with appropriate initial and boundary conditions. They are solved for the ranges of dimensionless space coordinate $0 \le x \le 1$ and time $t \ge 0$. Calculation of the intensity of back-scattered radiation $J_1(0,t) = J_1(x,t)|_{x=0}$ with an intensity of incident radiation typically $J_0(0,t) = f(t)|_{x=0} = \begin{cases} \sin^{2}(\pi t/2), & 0 \le t \le 2 \\ 0, & t > 2 \end{cases}$ reveals that both amplitude and duration of the reflected signal are determined by four parameters: the three coefficients in the equations of scattering and the amplitude of acoustic waves produced by thermal fluctuations at room temperature. The solution to these equations depends most strongly on the coefficient of $\partial J_{0,1}/\partial t$ and the coefficient of $\sqrt{J_0 J_1}$. The former represents the dimensionless length of the interaction space and should be small for appreciable pulse shortening, the latter governs the intensity of scattered radiation and should be large. Therefore the most effective media will be those with a large refractive index and thus a large coefficient of nonlinear coupling. The authors thank B. Ya. Zel'dovich, V. S. Starunov and I. L. Fabelinskiy for discussion of results and helpful comments. Figures 2, references 7: 6 Russian, 1 Western. [228-2415]

MANDEL'SHTAM-BRILLOUIN STIMULATED SCATTERING AND WAVEFRONT REVERSAL IN OPTICAL FIBERS

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 12, 26 Jun 82 (manuscript received 3 Mar 82) pp 729-732

PETROV, M. P. and KUZIN, Ye. A., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] An experimental study was made of Mandel'shtam-Brillouin stimulated scattering and wavefront reversal in multimode optical fibers. Fudamental frequency and second-harmonic emission from a YAG:Nd laser operating in a single mode with a line not wider than 10^{-2} cm^{-1} and a pulse duration of 30 ns was used for pumping, a Gaussian beam formed by means of a lens (focal length 200 mm) and a pinhole (diameter 150 μm) as space filter. Light was coupled into optical fibers through another lens (focal length 40 mm) with 100% efficiency. The fibers, made of phosphosilicate glass, were 30 μm in diameter with 0.15 aperture and 0.3-10 m long. Wavefront reversal was recorded photographically. Efficiency of conversion of pumping wave to reflected wave was measured as a function of pumping power. A conversion efficiency of 50% was reached at a pumping power equal to 300% of the threshold level. In order to increase the efficiency, it was necessary to stabilize the Mandel'shtam-Brillouin stimulated scattering process by use of pumping pulses of duration an order of magnitude longer than the phonon lifetime and thus lower the threshold pumping power. The latter was lower with fundamental-frequency pumping (1 kW) than with second-harmonic pumping (1.5 kW). Figures 2, references 5: 3 Russian, 2 Western.
[228-2415]

CONTROLLING DIFFRACTION EFFICIENCY OF DENISYUK'S REFLECTION HOLOGRAMS BY 'TURNING ON' GYROTROPY DURING RECORDING

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 12, 26 Jun 82 (manuscript received 12 Feb 82) pp 713-716

SHEPELEVICH, V. V., Mozyr' State Pedagogical Institute imeni N. K. Krupskaya

[Abstract] Recording of reflection holograms of plane waves in gyrotropic media by the Denisyuk method of three-dimensional holography is analyzed from the standpoint of controllable diffraction efficiency. The latter as a function of product βd is calculated by the method of coupled waves (d- thickness of gyrotropic layer, $\beta = \frac{2\pi}{\lambda} \frac{\alpha}{\cos \varphi_r}$, λ-wavelength, α-gyration parameter, φ_r-refraction angle), with gyrotropy "turned on" during recording and "turned off" during reconstruction. Such a control can be achieved by respectively

turning on and off a magnetic field or by turning on a compensating magnetic field during reconstruction. Calculation of the magnetic field intensities corresponding to unity and zero diffraction efficiency for fixed layer thickness involves solution of a transcendental equation. A comparison of diffraction efficiency as function of β at fixed d and as function of d at fixed β with analogous characteristics without gyrotropy demonstrates the feasibility of control by this method. Figures 2, references 14: 13 Russian, 1 Western.
[228-2415]

INFLUENCE OF GLASS SBS MIRROR BREAKDOWN ON WAVEFRONT REVERSAL

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 13, 12 Jul 82 (manuscript received 1 Feb 82) pp 816-819

BAL'KYAVICHYUS, P. I., DEMENT'YEV, A. S., LUKOSHYUS, I. P., MALDUTIS, E. K. and TARULIS, V. P., Institute of Physics, LiSSR Academy of Sciences, Vilnius

[Abstract] An investigation is made of the effect that damage to K-8 glass and KSG quartz glass has on the efficiency of subsequent stimulated Brillouin scattering and wavefront reversal. The second harmonic ($\lambda = 0.53\ \mu m$) of a neodymium glass laser was used. Beam divergence was $5 \cdot 10^{-4}$ rad, intensity distribution over the beam cross section was near gaussian, and pulse duration at half-amplitude was 20 ns. The glass SBS mirror under conditions of breakdown was characterized by the energy reflectivity and by the Stokes fraction of the energy propagating in a given angle. For KSG quartz glass it was found that the length of the damaged region increases toward the lens with each succeeding pulse, and SBS develops effectively only until the damaged region has approximately filled the entire length of the focus. The fraction of Stokes energy is weakly dependent on angle, about half the energy of the Stokes component being concentrated in the angle of pumping divergence regardless of the reduction of reflectivity with increasing dimensions of the damaged region at large numbers of pulses. Behavior is similar for K-8 glass except that reflectivity decreases much faster with increasing pulse number for the same focal lengths of lenses and pumping energies. Figures 2, references: 10 Russian.
[240-6610]

WAVEFRONT FORMATION BY TWO-DIMENSIONALLY PERIODIC STRUCTURES

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 13,
12 Jul 82 (manuscript received 22 Mar 82) pp 823-827

PUSTOVOYT, V. I. and CHERNOZATONSKIY, L. A., All-Union Scientific Research
Institute of Physicotechnical and Radiotechnical Measurements

[Abstract] It is shown on the example of acoustic surface waves that such waveforms can be generated at different angles on a two-dimensionally periodic interdigital transducer by varying the frequency of the controlling electric voltage. An analysis is made of the way that conditions of acoustic surface wave generation arise in two-dimensionally periodic structures of line and point type, and the consequences of such waves are considered. It is shown that at a fixed frequency the acoustic surface wave radiation pattern may contain several lobes, and as the frequency changes, not only the direction, but also the number of lobes will change. Figures 2, references 6: 4 Russian, 2 Western.

[240-6610]

UDC 535.241.13:537.228

USE OF SPACE-TIME LIGHT MODULATORS IN OPTICAL DATA-PROCESSING SYSTEMS

Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 82
(manuscript received 8 Feb 80, in final version 26 Mar 81) pp 6-12

NAGAYEV, A. I., PARYGIN, V. N. and PASHIN, S. Yu., Moscow

[Abstract] An electron-beam space-time light modulator using a DKDP crystal is considered from the standpoint of new applications such as transmission of holograms over a television channel. As the active element of a phase mask or adaptive optics, it must both deflect the light beam and straighten the front of a plane wave passing through a rectangular phase grating. Inscription of a ramp or equivalent sawtooth voltage in the electrooptic crystal by means of an electron beam is sufficient for deflection of the light beam. Attendant scattering of light determines the phase distortions and correction of the excessive ones depends on the crystal characteristics. Dependence of the light loss on the period of the sawtooth voltage and on the diameter of the inscribing electron beam was calculated on a computer and the loss was found to increase at a decreasing rate with increasing voltage period. The loss remains low as the diameter of the electron beam increases up to 40 μm and increases fast as the diameter increases further. The performance characteristics of such a modulator were also measured in an experiment with a DKDP crystal at its phase transition temperature (-52°C) and an electron beam 80 μm in diameter inscribing a sawtooth voltage profile with the optimum amplitude as well with amplitudes deviating by 10 and 20% from optimum. The corresponding light intensity distributions in the Fraunhofer zone produced by diffraction of a plane wave were also recorded, as were the light intensity distributions in the diffraction pattern of a predistorted wave and of the reconstructed wave. Experiments with transmission of holograms over a television channel indicate that reconstruction of images by this method requires that the band of space frequencies match the resolving power of the television channel and that the light modulator operate as amplitude modulator with suppressed constant component in the light beam. Figures 5, references 5 Russian.
[202-2415]

DEPENDENCE OF APPLICABILITY OF INJECTION LASERS IN MAGNETOOPTICAL DEVICES ON THEIR ENERGY AND NOISE CHARACTERISTICS

Leningrad PIS'MA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 8, No 11, 12 Jun 82 (manuscript received 12 Jan 82) pp 688-692

KUPRIYANOVA, N. G., MOROZOV, V. N., NIKITIN, V. V., POPOV, Yu. M., SEMENOV, G. I. and CHERVONENKIS, A. Ya., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Energy and noise characteristics of four heterostructure-injection lasers ($YFeO_3$, $Nd_{0.8}Pr_{0.2}FeO_3$, $Y_2BiFe_{3.8}Ga_{1.2}O_{12}$, $Tm_2BiFe_{3.8}Ga_{1.2}O_{12}$), both room lasers ($\lambda = 0.81$ µm) and those with one channel emitting linearly polarized light ($\lambda = 0.85$ µm), are reviewed from the standpoint of applicability in magnetooptic data processing devices. These characteristics such as sensitivity, efficiency, signal-to-noise ratio depend on several parameters which have been measured: Faraday rotation modulus, optical absorption coefficient, degree of radiation depolarization by magnetized specimen, optical contrast in image of domain structure, and optical efficiency. The magnetooptic properties are excellent, optical efficiency is low but can be improved by increasing the thickness of structures to the optimum for near infrared radiation (orthoferrites 150-200 µm, garnets 100 µm), noise immunity requires much smaller power fluctuation and much lesser radiation depolarization. Figures 2, table 1, references 6: 5 Russian, 1 Western.
[227-2415]

SUPERCONDUCTIVITY OF $CeCu_2Si_2$ COMPOUND

Moscow PIS'MA V ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 35, No 10, 20 May 82 (manuscript received 14 Apr 82) pp 435-438

ALIYEV, F. G., BRANDT, N. B., LUTSIV, R. V., MOSHCHALKOV, V. V. and CHUDINOV, S. M., Moscow State University imeni M. V. Lomonosov

[Abstract] An experimental study was made of $CeCu_2Si_2$ single crystals and polycrystalline $CeCu_2Si_2$, the only known variable-valence compound with superconductor characteristics. Their electrical properties were measured over the 0.05-300 K temperature range in a magnetic field of up to 20 kOe and under pressures from 0 to 8 kbar. The temperature dependence of the electrical resistivity was measured as well as the pressure dependence of the superconductive transition temperature and dependence of the critical intensity of a longitudinal parallel magnetic field on the superconductive transition temperature. In the case of polycrystalline specimens under zero pressure the electrical resistivity was found to dip slightly at 70 K and to drop sharply but not to zero at 0.5 K. In the case of single crystals there were no dip at 70 K and no superconductive transition under zero pressure, no dip at 70 K but a superconductive transition at 0.05 K under normal pressure (5.4 kbar). Under pressures above 2.5 kbar there seems to appear another modification of the compound with a superconductive transition temperature less dependent on the pressure and, in the case of single crystals, with an anomalously high ratio of critical magnetic field intensity to superconductive transition temperature. The authors thank R. I. Yasnitskiy for synthesizing $CeCu_2Si_2$ single crystals, S. G. Freyman for assisting with measurements at cryogenic temperatures, also D. I. Khomskiy and A. I. Buzdin for discussing the results. Figures 3, references 6: 1 Russian, 1 Polish, 4 Western.
[208-2415]

STIMULATION OF SUPERCONDUCTIVITY IN S-N-S JUNCTIONS BY MICROWAVE FIELD

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 82, No 5, May 82 (manuscript received 4 Dec 81) pp 1671-1677

ASLAMAZOV, L. G. and LEMPITSKIY, S. V., Moscow Institute of Steel and Alloys

[Abstract] Stimulation of superconductivity in S-N-S junctions by a microwave field is analyzed in terms of delayed and advanced Green functions in the equation of diffusion and their integrals with respect to an energy variable. The current density as a function of time, in the case of short mean free path of electrons, is expressed as the trace of matrices with elements made up of Gor'kov functions and ordinary Green functions. The critical current in a junction is calculated, and found to depend on the junction length (length of normal metal weak link) according to an inverse power law rather than exponentially. Calculations are based on weak electron-phonon interaction and zero order parameter in normal metal, with appropriate boundary conditions at the superconducting edges. Solution of the equation of kinetics according to perturbation theory confirms that the nonequilibrium component of the critical current is principally due to electrons with energy of the order of $\hbar D/d^2$ ($\hbar$- Planck constant, D- diffusion coefficient, d- length of normal metal weak link). The conclusions are valid for microwave frequencies higher than the reciprocal of the diffusion time D/d^2 and not excessively high microwave radiation power. The authors thank A. A. Abrikosov, K. K. Likharev and A. I. Larkin for valuable comments and discussion of results. References 16: 11 Russian, 5 Western.

[225-2415]

THERMODYNAMICS

UDC 536.422.1

DYNAMICS OF CRATER FORMATION BY HIGH-CURRENT CHARGED PARTICLE BEAMS IN METAL BARRIER

Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 26, No 6, Jan 82
(manuscript received 2 Oct 81) pp 496-499

ROMANOV, G. S. and SUZDENKOV, M. V., Scientific Research Institute of Physics
Application Problems imeni A. N. Sevchenko

[Abstract] The dynamics of action of a relativistic charged particle beam on an absorbing metal plate in an ambient cold gas (vapor), and the resulting crater formation, are analyzed on the basis of three equations of hydrodynamics and one equation of electrothermohydrodynamics in Euler variables. This system of equations is closed with an equation of state containing log P (P- pressure) and log $\varkappa_R$ ($\varkappa_R$- radiative thermal conductivity) in region of multiple ionization, both obtained from solution to the Saha equation and tabulated. These equations have been solved numerically on a computer, by the method of large particles, for an E_0= 0.5 MeV 54 GA/m^2 electron beam with 1 mm radius and 50 ns pulse duration striking a 0.95 mm thick aluminum plate. The profile of energy lost by a particle along its path was determined from tables based on the Monte Carlo method. The results yield the integral transient characteristics of crater formation parameter and the crater profile. They compare fairly closely with experimental data reported elsewhere. The authors thank A. V. Teterev for assisting in development of the calculation procedure. Article was presented by Academician M. A. Yel'yashevich, BSSR Academy of Sciences. Figures 2, references 13: 11 Russian, 2 Western.
[200-2415]

UDC 551.46.09

ESTIMATING COMPONENTS OF THERMAL FLUX FROM SEA TO ATMOSPHERE

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA
in Russian Vol 23, No 3, May-Jun 82 (manuscript received 13 Apr 81) pp 72-74

ANDREYEV, Ye. G. and PYRKIN, A. Yu., Chair of Physics of Sea and Inland Water, Moscow University

[Abstract] A method is proposed for estimating the heat of evaporation of sea water which utilizes the fact that heat transfer from sea to atmosphere occurs principally through evaporation and effective radiation, contact heat transfer being an order of magnitude smaller than the heat of evaporation and therefore negligible. It is thus merely necessary to synchronously record the total thermal flux and the effective radiation flux, the difference between them yielding the heat of evaporation. The accuracy of this method depends on the accuracy of recording instruments and on the actual magnitude of contact heat transfer. Such measurements were made on board a research vessel moving at a constant speed of 20 cm/s, with a copper-constantan thermocouple (response lag time not exceeding 1.5 ms) probing a 30 cm thick air layer above the water surface and penetrating 30 cm deep into the water. The thermocouple signal, after preamplification in a 1UT-401 microcircuit, was recorded with an S8-9A memory oscillograph. These measurements were made during August and September in the 1977-79 period. The total thermal flux averaged 260 W/m^2 over 24 hours, 180 W/m^2 from 9 PM to 8 AM and 300 W/m^2 from 8 AM to 9 PM, while the radiative flux averaged 45 W/m^2 over 24 hours. Accordingly, the heat of evaporation was estimated at 220 W/m^2 or approximately 80% of the total thermal flux. Figure 1, references: 4 Russian.
[222-2415]

UDC 536.2:517.947

UNAMBIGUOUS DETERMINATION OF HEAT SOURCE ON BASIS OF INDIRECT DATA

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 23, No 3, May-Jun 82 (manuscript received 10 Jul 80) pp 12-15

GLASKO, V. B., KONDORSKAYA, Ye. Ye. and BIDZINOV, Sh. M., Chair of Mathematics, Moscow University

[Abstract] The problem of unambiguously and correctly determining a heat source on basis of indirect data and regardless of a specific model is considered first in the case of a point source in a plane. The temperature field is described by the equations:

$\alpha^2\Delta T - \frac{\partial T}{\partial t} = f(t)\delta(x - x_0)$ (α- thermal diffusivity, T- temperature, t- time, f(t)- intensity of source, x_0- space coordinate of the source location), which yields $T(x,t) = \int_0^t G(x-x_0, t-\tau)f(\tau)d\tau$. There are three problems possible: 1) determine location x_0 of heat source when its intensity f(t) is known, 2) determine intensity f(t) of heat source when its location x_0 is known, 3) determine both x_0 and f(t). Unique determination of f(t) (first problem) requires knowing the temperature at three points not on one straight line, assuming that f(t) is a continuous non-negative function. Unique determination of x_0 (second problem) requires knowing the temperature as a function of time at one arbitrary point, assuming that f(t) is a continuous bounded function, with the additional constraint that the temperature at any given time be a function of the space coordinate. Unique determination of x_0 and f(t) requires knowing the temperature at three points not on one straight line, as a function of time at one point, and only at some arbitrary instants of time at the other two. On this basis both parameters can be determined simultaneously by an appropriate iteration process. Analyticity of f(t) in both problems 2) and 3) can be established by asymptotic analysis. In the case of a finite heat source the problem can be solved according to several successively more complex models, the first one being a source localized within a given volume g with uniform intensity distribution f(x,t) so that

$$\alpha^2\Delta T = \frac{\partial T}{\partial t} = \begin{cases} -f(t), & x \in g \\ 0, & x \notin g \end{cases}, T|_{t=0} = (x).$$

Figures 2, references 5 Russian.
[222-2415]

MATHEMATICS

UDC 519.2.83

NONAUTONOMOUS PROBLEM OF EVASION

Moscow AVTOMATIKA I TELEMEKHANIKA in Russian No 6, Jun 82
(manuscript received 2 Jul 80) pp 81-86

OSTAPENKO, V. V.

[Abstract] The nonautonomous problem of differential evasion games is analyzed for a dynamic system describable by the equation $\dot{z}= f(z,u,v,t)$ ($z \in E^n$, $u \in U$, $v \in V$, E^n n-dimensional Euclidean space, U and V compacts in Euclidean spaces), with the terminal set depending on time and with function $f(z,u,v,t)$ continuous in z,u,v and summable in t. With u and v replaced by u(t) and v(t) respectively, there exists a solution to that equation for any arbitrary initial state (z_0,t_0) and this solution can be continued along the entire (t_0,∞) semiaxis. The sufficient conditions for evasion are formulated in terms of two assumptions about function $f(z,u,v,t_0,\ldots,t_k)$ and two assumptions about functions ε_0 and ε_j ($j= 1,2$) respectively. A theorem states that evasion is possible when the first two and one of the other two assumptions are met. This theorem is proved here for both cases. The outcome of the game is demonstrated on two examples of pursuer and evader dynamics. References 12 Russian.
[221-2415]

UDC 621.391.1:519.28

NONPARAMETRIC SIGNAL ESTIMATION ON BASIS OF INCOMPLETE INFORMATION ABOUT NOISE DISTRIBUTION

Moscow PROBLEMY PEREDACHI INFORMATSII in Russian Vol 18, No 2, Apr-Jun 82
(manuscript received 15 Jun 81) pp 44-60

TSYBAKOV, A. B.

[Abstract] Nonlinear estimators, nonparametric analogs of M-estimators consistent in large classes of functions, are proposed for restoration of a signal

$f(x)$ on basis of n observations(x_i, y_i), where $y_i = f(x_i)+\xi_i$ $(i= 1,2,\ldots,n)$ and ξ_i is a noise with infinite dispersion (x_i- independent random vectors with identical distributions, ξ_i- independent quantities with identical distributions and independent of x_i). The value of the signal in each estimate is defined as $f_n(x)= \arg\min_{f^-\leq t\leq f^+} \sum_{i=1}^{n} F(y_i - t)K(\frac{x_i-x}{h_n})$, where $F(u)$ is a regular convex function of a real variable and K is a regular Parzen kernel with $h_n > 0$ a number depending on the sample size. These estimators and their approximations are tested for convergence with the aid of two theorems, whereupon the lower bounds for the corresponding risk are established on basis of a third theorem and two corollaries. The estimators are then optimized in the sense of fastest convergence by proper selection of K, h_n and $\psi(u)= F'(u)$ in accordance with three other theorems, each followed by a corollary. Application of such estimators is demonstrated on four classes of noise distributions: with finite dispersion, with overall zero median, with distorting distribution symmetric to the main one, and single (exactly known) distribution. The author thanks B. T. Polyak and R. Z. Khas'minskiy for taking interest in this study. References 22: 13 Russian, 9 Western.
[201-2415]

UDC 621.391.15:519.28

QUASI-OPTIMUM METHODS OF CORRELATIONAL RECEPTION FOR REED-SOLOMON CODES

Moscow PROBLEMY PEREDACHI INFORMATSII in Russian Vol 18, No 2, Apr-Jun 82
(manuscript received 27 Apr 79, after revision 25 Sep 79) pp 12-21

NEMIROVSKIY, E. E.

[Abstract] Quasi-optimum methods simpler than parallel correlational reception are proposed for decoding Reed-Solomon codes in a Gaussian channel. One method involves comparing, in Euclidean metrics, all possible C_n^{d-1} erasures of d-1 symbols and their subsequent restorations, with most likely values serving as nonerased symbols and restored symbols constituting linear forms of nonerased ones. Another method is the "sliding subgraph" with a quasi-optimum modifications of the Viterbi asymptotically optimum algorithm. Three modifications have been tested experimentally by statistical simulation: "list" method algorithm with constant number of most likely states of Reed-Solomon coder, "threshold" method algorithm with random number of states deviating from current maximally likely one by not more than a preset threshold probability difference, and combination algorithm of threshold method with limited list. Figures 5, references 9: 4 Russian, 5 Western.
[201-2415]

UDC 621.391.15:519.28

METHOD OF ESTABLISHING LOWER BOUNDS FOR REDUNDANCY IN UNIVERSAL CODING

Moscow PROBLEMY PEREDACHI INFORMATSII in Russian Vol 18, No 2, Apr-Jun 82
(manuscript received 16 Jan 81, after revision 14 Dec 81) pp 3-11

SHTAR'KOV, Yu. M.

[Abstract] Lower bounds for redundancy in universal coding of a source without memory and for efficiency of a code in the set of sources are established on the basis of rather rough estimates requiring few computations. An enabling theorem pertains to words generated by letters of a countable discrete alphabet and uses a lemma which pertains to the error of a decision rule for maximizing the code efficiency, proved with aid of the Chebyshev inequality and the estimate $\log (1+z) \leq z$ $(z>-1)$. This method of establishing lower bounds is demonstrated on two examples, a stationary Poisson source and a Markov source, a theorem being proved for each pertaining to existence of asymptotically optimum codes of maximum probabilities. More accurate lower-bound estimates are obtained on the basis of appropriate a priori source distributions. The author thanks M. V. Burnashev for suggesting the possibility of simpler calculation and for helping with it. References 12: 9 Russian, 3 Western.
[201-2415]

UDC 517.948.3

OPERATOR METHOD OF SOLVING SYSTEM OF PAIRED INTEGRAL EQUATIONS RELATED TO MEIER-FOCK INTEGRAL TRANSFORMS

Kiev UKRAINSKIY MATEMATICHESKIY ZHURNAL in Russian Vol 34, No 3, May-Jun 82
(manuscript received 29 Dec 80) pp 316-321

PONOMARENKO, S. P., Institute of Management of the National Economy, Kiev

[Abstract] An operator method is proposed for solving the system of paired integral equations

$$P^{\mu}[A_j(\tau)\Psi(\tau)] = f^{(j)}(x)$$

$P^{\mu}[\Psi(\tau)] = \int_0^{\infty} \rho_{-\frac{1}{2}+i\tau}^{-\mu}(\cosh x)\Psi(\tau)d\tau$ $(0 \leq x < \infty)$ operator of generalized Meier-Fock integral transformation, $\rho_{-\frac{1}{2}+i-}^{-\mu}(\cosh x)$ associated Legendre function with complex index, μ real parameter, $\Psi(\tau) \in L(0,\infty)$, $\Psi(\tau)$ column matrix with components $\Psi_k(\tau) \in L(0,\infty)$. The method is based on properties of operator P^{μ}, namely

its relations with operators of fractional integration and sine-cosine Fourier transformations. The algorithm of such a solution is constructed here and applied to two typical boundary-value problems. References 5: 3 Russian, 2 Western.
[212-2415]

UDC 517.948.34

ASYMPTOTIC SOLUTION TO SYSTEM OF LINEAR INTEGRO-DIFFERENTIAL EQUATIONS OF RATIONAL RANK

Kiev UKRAINSKIY MATEMATICHESKIY ZHURNAL in Russian Vol 34, No 3, May-Jun 82 (manuscript received 15 Dec 80) pp 279-288

VORONOY, A. N., Kirovograd Pedagogical Institute

[Abstract] The problem is the system of linear integro-differential equations

$$\varepsilon^{\frac{k}{n}}\frac{dx(\tau,\varepsilon)}{d\tau} = A(\tau,\varepsilon)x(\tau,\varepsilon)+\rho\int_0^1 K(\tau,\sigma,\varepsilon)x(\sigma,\varepsilon)d\sigma$$

$x(\tau,\varepsilon)$ unknown p-dimensional vector, $\varepsilon>0$ small parameter, k and n natural relatively prime numbers, ρ arbitrary real parameter, $A(\tau,\varepsilon)$ and $K(\tau,\sigma,\varepsilon)$ real square matrices of order p representable as asymptotic series in ε^r. The solution to this system depends on the roots of the characteristic equation

$$\det\,(A^{(0)}(\tau)-\lambda E) = 0 \quad (E\text{- unit matrix})$$

and on the solution to the degenerate equation

$$A^{(0)}(\tau)\varphi(\tau)+\rho\int_0^1 K^{(0)}(\tau,\sigma)\varphi(\sigma)d\sigma = 0 \; (\varepsilon= 0)$$

A formal solution is obtained in the regular case of introduction of parameter $\mu^n =$ $(\mu>0)$ and application of two theorems with a lemma pertaining to its existence and asymptotic properties. An asymptotic solution is obtained in the case of non-zero eigenvalue by reduction to the regular case on the basis of a third theorem. References 4: 3 Russian, 1 Western.
[212-2415]

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USSR REPORT

PHYSICS AND MATHEMATICS

No. 82

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UDC 534.26

RADIATION OF SOUND BY COAXIAL CYLINDRICAL SHELLS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 28, No 4, Jul-Aug 82
(manuscript received 12 Dec 80) pp 470-473

VOVK, I. V.

[Abstract] Two thin coaxial cylindrical shells are considered, both infinitely long, separated by a periodic array of acoustically soft annular barriers and a fluid filling the spaces between these barriers. Inside the inner shell is vacuum, outside the outer shell is an ambient fluid with a characteristic impendance different from that of the fluid separating the shells. Radiation of sound by the outer shell vibrating uniformly under uniform external pressure is analyzed on the basis of equivalent series and parallel mechanical impedance circuits. The resonance frequency of the outer shell is found to depend on the inner shell and the fluid between shells, decreasing as the thickness of the inner shell and that of the separating fluid layer are decreased. Figures 3, references 4 Russian.
[238-2415]

UDC 534.222

COHERENT EFFECTS DURING BACKSCATTERING OF SOUND BY BODIES NEAR WAVY SEA SURFACE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 28, No 4, Jul-Aug 82
(manuscript received 29 Apr 81) pp 438-440

AKHUNOV, Kh. G., Moscow State Pedagogical Institute imeni V. I. Lenin, and KRAVTSOV, Yu. A., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Coherent effect are analyzed that accompany backscattering of sound by a particle or bubble under a wavy sea surface and that amplify the scattered signal. With underwater transmitter and receiver at the same

location, there are four paths of sound rays to be considered: transmitter-scatterer-receiver, transmitter-surface-scatterer-receiver, transmitter-scatterer-surface-receiver, and transmitter-surface-scatterer-surface-receiver. The resultant signal intensity measurable at the receiver is calculated taking into account wave motion of the water surface and assuming a unity 100% reflectance. The condition is also established for transition of the two "cross channels" (with reflection of only forward rays and only return rays, respectively, by the surface) from coherent to noncoherent ones, when amplification due to their addition reduces from fourfold to twofold. A numerical example, with transmitter and receiver at same depth as scatterer, illustrates the dependence of path difference and correlation retention time on length and height as well as vertical velocity of the dominant water wave. Figure 1, references 3 Russian.
[238-2415]

UDC 534.21

ATTENUATION OF LOW-FREQUENCY SOUND IN TURBULENT MEDIUM

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 28, No 4, Jul-Aug 82
(manuscript received 23 Dec 80) pp 521-522

KUZNETSOV, V. P., Institute of Oceanology imeni P. P. Shirshov, USSR Academy of Sciences

[Abstract] Attenuation of sound in a turbulent medium is analyzed, taking into account energy transfer between potential flow mode and vortical flow mode through "vortex-sound" and "sound-sound" as well as "vortex-vortex" interactions. The total velocity field is expressed as the sum of the potential mode and the vortical mode, the corresponding equation of motion is linearized and approximated by omission of insignificant terms, then solved for low values of the Reynolds number. A subsequent Fourier transformation and application of the "mean field" method yield the dispersion equation for the coherent part of the wave field. This equation indicates that in a homogeneous and isotropic medium with small-scale turbulence there occurs additional absorption of sound that does not depend on the frequency of sound. References 2: 1 Russian, 1 Western.
[238-2415]

UDC 621.315.592

ACOUSTOCONCENTRATION EFFECT PRODUCED WITH VOLUME ACOUSTIC WAVES

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 6, Jun 82 (manuscript received 29 Jul 81, final edition received 14 Dec 81) pp 1075-1077

TIMAN, B. L., KOMAR', V. K. and SELEGENEV, Ye. M.

[Abstract] The theoretically predicted acoustoconcentration effect produced in an open semiconductor crystal by passage of an ultrasonic wave has been confirmed experimentally in a CdS crystal. The dependence of this effect, namely of the gradient of electron and hole concentrations (maximum deviation from equilibrium concentrations occurring at the crystal faces), on the resistance of the crystal was determined as well as the dependence of the amplification of surface acoustic waves on the magnitude of this effect. In the experiment a = yayev-Gul-Bluestein wave was excited at the crystal surface and amplified by means of an electric drift field. Transverse acoustic pumping was found to change the SAW gain, decreasing or increasing it depending on the resistance of the surface layer ($2\cdot10^3$ ohms and $6\cdot10^3$ ohms respectively), as a result of interaction of a propagating acoustic noise pulse with conduction electrons in the crystal (resistivity $\rho \cong 10^4$ $\text{ohm}^{-1}\cdot\text{cm}^{-1}$) and consequent redistribution of charge carrier concentrations with an exponential rise in the direction of noise propagation. At the point of maximum SAW gain, corresponding to a surface layer with a resistance of $3.5\cdot10^4$ ohms acoustic pumping does not significantly change the SAW gain. The acoustic noise in this experiment covered a wide frequency range, from tens to hundreds of megahertz, so that the acoustoconcentration effect decreased monotonically with increasing crystal resistance. An analogous experiment with coherent sound pumping a quartz transducer with resonance frequency of 32 MHz yielded similar results but a weaker acoustoconcentration effect. Figures 4, references 2: 1 Russian, 1 Western.
[237-2415]

UDC 621.378.9:681.327

EFFECT OF GAMMA RADIATION ON SOME PROPERTIES OF GLASSY CHALCOGENIDE SEMICONDUCTORS

Tashkent IZVESTIYA AKADEMII NAUK UzSSR: SERIYA FIZIKO-MATEMATICHESKIKH NAUK in Russian No 3, May-Jun 82 (manuscript received 25 Feb 81) pp 37-39

AZAMATOV, Z. T., GULANYAN, E., KIM, V. M., SADYKOVA, Sh. Z. and KADYROVA, D. R., Order of Labor Red Banner Institute of Cybernetics with Computer Center, UzSSR Academy of Sciences

[Abstract] An experimental study was made to determine irreversible changes caused by γ-radiation in optical properties of thin films of glassy chalocogenide semiconductors used for holographic data recording and storage. The test equipment included an LG 38 helium-neon laser ($\lambda = 0.63$ µm), a cubic light splitting prism, two plane mirrors, one semitransparent plate, two diaphragms, two neutal filters, two photoreceivers, three shutters and two potentiometer-type recording instruments. Holograms in the form of diffraction gratings were produced by interference of the two light beams coming from the splitter prism. By opening and closing appropriate shutters, the two potentiometers were made to measure the intensities of both recording light beams, to measure the diffraction efficiency (intensities of incident and diffracted beams), and to measure the transmission coefficient (intensities of incident and transmitted beams) respectively. Specimens of As_7Se_3 and $As_{60}Se_{40}$ films vacuum-deposited on glass and sapphire substrates were held in aluminum capsules and exposed to γ-radiation from a ^{60}Co source in doses up to 10^9R. The results indicate that γ-radiation does not significantly affect the holographic characteristics of chalcogenide films but causes the transmittivity of optical glass and sapphire substrates to decrease very appreciably, from about 0.9 to below 0.1, with opacity saturating at 10^4-10^7 R. Figures 2, reference 1 Russian.
[247-2415]

UDC 621.315.592

SURFACE RECOMBINATION WAVES IN SILICON

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 6, Jun 82 (manuscript received 27 May 81, final edition received 9 Nov 81) pp 1102-1104

GULE, Ye. G. and KLIMOVSKAYA, A. I., Institute of Semiconductors, UkSSR Academy of Sciences, Kiev

[Abstract] Oscillations have been detected in n-type and p-type silicon that depend on film thickness, film temperature, and excitation mode (constant current or constant voltage). A mechanism of this instability has also been proposed that involves not volume but surface recombination waves produced by exchange of charges of surface states and in which the space charge field plays an important role. Experiments were performed with thin silicon films with free charge carrier concentrations within the 10^{15}-10^{16} cm^{-3} range and with the temperature varied from room to 77 K. In these experiments the authors determined the current-voltage characteristics, and the oscillation waveforms depending on the excitation mode, also the dependence of the pulse repetition rate on the pulse amplitude and the excitation current or voltage. The results reveal that the instability depends on the film thickness within the order of magnitude of the Debye shielding length (0.5 μm), ceasing in films thicker than 40 μm, and on the curvature of energy bands at the surface. The oscillation frequencies are comparable with frequencies of exchange of free charge carriers of surface states (100 kHz) and vary linearly with the excitation current or voltage. Figures 2, references 8: 7 Russian, 1 Western.
[237-2415]

UDC 621.315.592

ION IMPLANTATION OF IMPURITIES INTO $n\text{-Hg}_{0.8}\text{Cd}_{0.2}\text{Te}$, PART 2: GROUP-III Al^+, Ga^+ IONS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 6, Jun 82 (manuscript received 20 Apr 81) pp 972-977

VODOP'YANOV, L. K., KOZYREV, S. P. and SPITSYN, A. V., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] Experimental studies have revealed that the electrical properties of $n\text{-Hg}_{0.8}\text{CD}_{0.2}\text{Te}$ are changed much more by implanation of group-III ions (Al^+,Ga^+) than by implanation of group-II ions (Mg, Zn^+, Cd^+). Crystals of this material with an electron concentration $n < 10^{16}$ cm^{-3} at 85 K were bombarded with 150 keV Al^+ ions or 300 keV Ga^+ ions. The infrared reflection spectra of this material with various ion implantation layers were measured before and after annealing. The data were then processed by the method of

varying the dispersion parameters in the "damped oscillator" model. The resultant dependence of electron concentrations in the surface layer and in the substrate on the implantation dose follows different trends immediately after implantation and then after annealing, which indicates also atomic diffusion and not only radiative defects plays a substantial role in the process. The authors thank L. V. Keldysh for discussing the results. Figures 6, table 1, references 7: 3 Russian, 4 Western.
[237-2415]

UDC 621.382

CHANGE IN STRUCTURE AND IN PHYSICAL PROPERTIES OF SEMICONDUCTORS DUE TO PULSING LASER RADIATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1090-1096

KIYAK, S. G., Institute of Application Problems in Mechanics and Mathematics, UkSSR Academy of Sciences

[Abstract] Recrystallization of semiconductors from the liquid phase after local heating and melting of crystals by a pulse laser is examined on the basis of studies that deal with the epitaxial crystallization process. Changes in structure and in electrophysical properties, essentially manifested in redistribution of impurities and intrinsic defects as well as in type of conductivity and in some cases formation of photosensitive n-p junctions, have been established experimentally in $Pb_{1-x}Sn_xTe$, $Pb_{1-y}Sn_ySe$, Cd $Hg_{1-z}Te$, InSb, PbSe, CdSb and CdTe. According to results of examination under an electron microscope with resolutions down to 10 Å, melt recrystallization at the anomalously high rates of 3-4 m/s produces layers without line defects but only as far down as the liquid phase has advanced. Full electrical activation of impurities is attainable during laser doping and annealing processes, with the solubility of dopant elements exceeding the equilibrium limit of solubility for impurities in the solid phase by 1-2 orders of magnitude. Laser treatment of semiconductor materials, especially wideband ones, can be intensified and optimized by action of two lasers with different spectral and energy characteristics, either pulsed of CW, inasmuch as the coefficient of light absorption by excess charge carriers is proportional to the wavelength squared, also by proper selection of process temperatures. Figures 2, table 1, references 41: 28 Russian, 13 Western.
[232-2415]

UDC 621.315.592

FORMATION AND BUILDUP OF STRUCTURAL DEFECTS IN CdS CRYSTALS UNDER LASER RADIATION AND THEIR EFFECT ON OPTICAL AND ELECTRICAL PROPERTIES OF LATTER

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1037-1043

BRODIN, M. S., DAVYDOVA, N. A. and SHABLIY, I. Yu., Institute of Physics, Ukrainian Academy of Sciences

[Abstract] An experimental study was made of defect formation and buildup in crystals under laser radiation, on the basis of analysis of changes in the recombination spectra and for the purpose of determining the effectiveness of this method of analysis. The study objects were high-resistivity CdS crystals with concentration of free electrons of the order of 10^{14} cm^{-3}. They were irradiated at 300 K with pulses of $2\cdot10^{-8}$ s duration from a Q-switched multimode ruby laser ($\lambda = 0.69$ µm). Emission was focused by a lens and passed through neutal filters for regulation of the power density over the 10-100 MW/cm^2 range. Spectra of recombination radiation were measured at 4.2 K, after irradiation with various doses and after etching off a 1 um surface layer. These spectra reveal the evolution of exciton bands (4850-4900 Å), X-band (4875-4878 Å), Z-band (wide with $\lambda_m = 4878$), extreme greem ($\lambda > 5000$ A) with increasing concentration of donor centers up to a 10^{18} cm^{-3} excess of donor centers over acceptor centers, and eventual merging of two energy bands (impurity and conduction). Figures 3, table 1, references 13: 8 Russian, 5 Western.
[232-2415]

UDC 621.315.592

KINETICS OF ACCUMULATED RADIATION DAMAGE WITH ION IMPLANTATION IN SILICON

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 8, Aug 82 (manuscript received 24 Jun 81) pp 1390-1395

VAVILOV, V. S., KRASNOPEVTSEV, V. V. and KUDYSHEV, A. N., Physics Institute imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] The method of radiation conductivity induced by fast electrons is used to study the kinetics of accumulation of radiation damage during ion implantation in silicon. Radiation conductivity is reduced by the formation of radiation defects. Excitation of nonequilibrium charge carriers by electrons can be used to control the depth of the region of electron-hole pair production by changing particle energy. Experiments were done on implantation of He, C, N, Ne, Si, Ar and Kr ions with energy of 30 keV at temperatures of 300 and 100 K. The nonequilibrium carriers were excited by an electron gun producing electrons with energy of 10 keV at current density of 0.1 mA/cm^2. Ion production was done at a current density of 0.4-1 µA/cm^2, which is far

below the threshold where ion current can affect processes of defect formation and amorphization of silicon. The results are given as curves showing the change in number of radiation defects with ion dose as a function of the mass of the implanted ions and the temperature of the target. It is found that as the temperature of the substrate decreases, there is a reduction in the amorphization dose for all ions, and an increase in the rate of accumulation of radiation defects. For light ions, a simple mechanism of defect accumulation predominates where the number of displaced atoms is proportional to the ion dose. Defect accumulation for heavier ions is characterized by an amorphization mechanism with formation of amorphous regions that repeatedly overlap. Figures 5, references 17: 14 Russian, 3 Western.
[259-6610]

UDC 621.315.592

REDISTRIBUTION OF ION-IMPLANTED PHOSPHORUS IN SILICON WITH ANNEALING UNDER CONDITIONS OF HYDROSTATIC STRESS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 8, Aug 82 (manuscript received 8 Jan 82) pp 1489-1490

OKULICH, V. I., PANTELEYEV, V. A. and VASIN, A. S., Gorkiy Physicotechnical Research Institute, Gorkiy State University imeni N. I. Lobachevskiy

[Abstract] The authors study the possibility of using hydrostatic pressure to control diffusion processes when annealing layers of ion-implanted silicon. A model experiment was done to study diffusion of phosphorus from a layer of ion-implanted silicon in argon at pressures of 100-150 kPa. The specimens were annealed at 870, 905 and 920°C. Phosphorus distribution was determined by a four-probe method with removal of layers by anodic oxidation. The results show that pressure appreciably reduces the depth of dopant penetration. When specimens with surface concentration higher than 10^{20} cm^{-3} are annealed, the pressure increases the concentration of electrically active dopant in the zone of irradiation. Thus it should be possible to use hydrostatic pressure to profile the distribution of dopant atoms in semiconductors, specifically for increasing the coefficient of utilization of implanted ions and making sharp p-n junctions. Figure 1, references 8: 6 Russian, 2 Western.
[259-6610]

UDC 621.315.592

ELECTRONIC ABSORPTION AND AMPLIFICATION OF SOUND IN SEMICONDUCTORS IN ALTERNATING ELECTRIC AND MAGNETIC FIELDS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 16, No 8, Aug 82 (manuscript received 24 Aug 81, after revision 2 Mar 82) pp 1517-1519

SMBATYAN, Zh. Ye., GULYAYEV, Yu. V. and BUGAYEV, A. S., Institute of Radio Engineering and Electronics, USSR Academy of Sciences, Moscow

[Abstract] Previous research has demonstrated that electronic absorption and amplification of sound in semiconductors are strongly altered in the presence of an electric field alternating at a frequency much less than that of the sound, and that a transverse magnetic field may also have a considerable influence on the magnitude of the electric field that corresponds to optinum amplification of sound. In this paper it is shown that an alternating magnetic field may also have a considerable effect on electronic absorption and amplification of sound. In particular, with appropriate selection of the phase relations between the alternating magnetic and electric fields, volumetric acoustic waves can be amplified even in the absence of a constant electric field. References 5 Russian.
[259-6610]

ELECTRICITY AND MAGNETISM

UDC 536.423.1

METAL VAPORIZATION BY STRONG ELECTRIC CURRENTS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 5, No 8, Aug 82
(manuscript received 3 Oct 80) pp 1647-1652

MIKITIK, G. P., MOTORIN, V. I. and MUSHER, S. L., Novosibirsk State University imeni Lenin Komsomol

[Abstract] The melting stage in the process of electrical explosion of conductors was analyzed in a previous paper [see A. P. Baykov, A. M. Iskol'dskiy, G. P. Mikitik et al, ZHURNAL PRIKLADNOY MEKHANIKI I TEKHNICHESKOY FIZIKI, No 5, 1979]. This paper now continues with the second stage, vaporization. The problem is similar in some ways to that of vaporization of a solid surface by an intense laser beam or relativistic particle beam. Two stages are distinguished in the process of vaporization of a conductor by current flowing through it: "quasiequilibrium" vaporization where the vapor parameters are close to those of the saturated vapor, and "strongly nonequilibrium" vaporization where vapor pressure is much higher than ambient air pressure. The principal equations are derived, and dimensionless times are defined for temperature relaxation, input of energy necessary for vaporizing the conductor, and travel of a sound wave across the solid. The principal modes of vaporization are determined by relations among these characteristic times. The part played by the vaporization stage in the mechanism of distruction of conductors by electrical explosion is determined on the basis of qualitative estimates and numerical calculation of the principal equations. It is shown that the fraction of vaporized material is insignificant until a critical temperature is reached in the center of the specimen. Figures 3, references 13: 11 Russian, 2 Western.
[254-6610]

UDC 621.375.826+662.986

FEASIBILITY OF GAS DYNAMIC CO_2-LASER WITH REGENERATIVE HIGH-TEMPERATURE HEAT EXCHANGER: PART 1

Dushanbe IZVESTIYA AKADEMII NAUK TADZHIKSKOY SSR: OTDELENIYE FIZIKO-MATEMATICHESKIKH, KHIMICHESKIKH I GEOLOGICHESKIKH NAUK in Russian No 4(82), Oct-Dec 81 (manuscript received 25 May 81) pp 14-19

KARPUKHIN, V. T. and CHERNYSHEV, S. M., Institute of High Temperature, USSR Academy of Sciences

[Abstract] The feasibility of producing CW and pulse-periodic gas dynamic lasers on $CO_2 + N_2 + H_2O(He)$ mixtures is examined from both theoretical and practical standpoints. The operating principle of such lasers is based on thermal excitation of vibrational degrees of freedom of molecules in the active medium and subsequent rapid expansion of the medium through a supersonic Laval nozzle. The main performance parameter, namely specific emission power, of such lasers is evaluated on the basis of gas thermodynamic relations and found to increase from 42 J/g at $T_0 = 1500$ K to 210 J/g at $T_0 = 3000$ K. Four methods of heating the gas mixture are available: electrically with resistance heater, by combustion of CO together with nitrogen and water vapor producing additives, by preheating each mixture component in an electric arc (plasmatron), and by heat transfer in surface-type (recuperative) or contact type (regenerative) heat exchangers. All four methods are reviewed comparatively, heat exchangers being of particular interest as devices least developed and yet highly promising for this application. Recuperators are most economical to build, but they are least efficient and not yet optimally designed for high-temperature operation. Regenerators with movable packing are still in the experimental stage of development, regenerators with Cowper packing are reliable but still too large and expensive. Regenerators with ball packing feature a large specific heating surface and combine high reliability with low cost. With spherical Al_2O_3 or ZrO_2 granules used for packing, it is possible to operate at temperatures of 2100 or 2600 K respectively. References 20: 17 Russian, 3 Western.

[248-2415]

UDC 621.375.826

CONTINUOUS-WAVE SELECTIVE HIGH-TEMPERATURE GAS-DYNAMIC CO_2-LASER

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 3, May-Jun 82 (manuscript received 19 May 81) pp 573-579

YEGOROV, V. E., YERMACHENKO, V. P., KUROCHKIN, Yu. V., LAZUTKIN, O. N., PAKHOMOV, N. Yu., PUSTOGAROV, A. V., SHAN'GIN, O. S. and ERNST, V. Ye., Moscow

[Abstract] A test stand has been built for study of CW high-gemperature gas-dynamic lasers with selective thermal excitation, their performance and applications. The equipment includes a CO_2-laser excited during mixing of CO_2+ He with a supersonic N_2 stream (typically $48\%mN_2+ 16\%mCO_2+ 36\%mHe$), the latter heated in a d.c. electron-arc plasmatron. It also includes an optical resonator, a nozzle, a supersonic diffuser, a gas ejector, and a subsonic nozzle. Gain and resonator output power are measured with a probing LG-22 laser, modulator, three semitransparent mirrors, three photoreceivers, all mounted separately to ensure interference immunity during strong mechanical vibrations. The gain was found to increase with decreasing static pressure and to decrease with increasing distance from the nozzle throat. Its dependence on the stagnation pressure of nitrogen reveals a peak at approximately 2000 K, which shifts somewhat depending on the expansion ratio. At low temperatures the gain does not depend on the expansion ratio. Helium plays an important role in lowering the translational temperature of the active medium, as indicated by an approximately 33% decrease of gain upon replacement of helium with water. An output power of 45 W was attained with a beam hole $2 \cdot 10^{-3}$ m in diameter in the exit mirror. The authors thank B. A. Tikhonov and B. V. Abakumov for constructive discussion of the results. Figures 6, references 8: 7 Russian, 1 Western.
[230-2415]

UDC 621.378.325

SHAPE OF STABILIZED CRATER FORMING DURING VAPORIZATION OF SOLID SUBSTANCE UNDER LINEARLY POLARIZED LASER RADIATION

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 6, Jun 82 (manuscript received 2 Mar 81, final edition received 18 Aug 81) pp 1139-1140

BARANOV, R. I. and KILL', I.D.

[Abstract] The problem of the shape of a stabilized crater forming in a homogeneous isotropic dielectric material under normally incident linearly polarized laser radiation is treated analytically. The equation of the crater surface is derived with the aid of Fresnel relations for the reflection coefficients, with stabilization of the crater assumed to occur when the energy

absorbed in a unit of time through an arbitrarily small area of the crater surface becomes equal to the energy absorbed in the same time in a region of equal area where the stabilized crater reaches the original surface where only radiation polarized normally to the plane of incidence appears. Stabilization of the crater surface is also assumed to require complete absorption of the reflected wave and use of its entire energy on vaporization. The second-degree first-order partial differential equation in cylindrical coordinates was solved numerically for a laser beam with normal intensity distribution. The results reveal a not nonaxisymmetric crater, with the half-plane at $\theta = 0$ smoothly merging with the original surface and the half-plane at angle $\theta - \frac{1}{2}\pi$ intersecting that surface at some angle (0- polar angle in a plane perpendicular to the laser beam). Figures 2, references 1 Russian.
[235-2415]

UDC 535.21:541.14

INSTABILITY OF VAPORIZATION AND OF SURFACE OXIDATION UNDER LASER RADIATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1127-1134

TRIBEL'SKIY, M. I.

[Abstract] Interaction of laser radiation and solid material is considered which results in instability of two processes: sublimation (vaporization) and oxidation. The problem is treated as one of a physical system with perturbation and change of symmetry. The model for sublimation is a semi-infinite body (half-space) and laser radiation of constant intensity entering through its surface. The effect of the vaporization front moving depthwise through the temperature field is evaluated in the adiabatic approximation with appropriate boundary conditions. The evolution of evaporation instability is traced through its initial linear stage by analytical methods and through the subsequent nonlinear stage by numerical methods. It has been demonstrated that development of instability slightly above the threshold produces stable two-dimensional stationary structures whose space period depends on the initial conditions and all other parameters remain universal so that from any initial conditions in a continuous class there will always evolve the same stationary structure, a typical example being the spin mode of evaporation. The model for oxidation is an oxide film building on the surface a bulky metal specimen. The effect of incident laser radiation on this process is evaluated on the basis of the homogeneous differential equation of heat conduction and the parabolic law of oxide film kinetics. Results obtained by both analytical and numerical methods reveal that as the film thickness increases slowly, stable and unstable stages of film buildup alternate with instability which is first linear and then nonlinear. Experimental data are available on vaporization of metals and dielectrics such as quartz as well as on oxidation of metals such as copper, a CO_2-laser ($\lambda = 10.6\ \mu m$) having been used in those studies. Figures 6, references 11: 9 Russian, 2 Western.
[232-2415]

UDC 621.375.826

STATISTICS OF BREAKDOWN BY LASER RADIATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1119-1126

DANILEYKO, Yu. K., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Threshold laser radiation causing breakdown of a defective material is defined as the minimum intensity at which irreversible structural changes occur around a defect in the material, through any of various mechanisms such as buildup of thermoelastic stresses or of absorption waves, electron avalanche or bursting due to heat. All breakdown causing processes are random in nature and describable by Poisson statistics. A problem in studying laser-induced breakdown is determining the probability density function, generally of several random variables, which characterizes the probability of breakdown within a unit of time and thus characterizes the material with respect to its destructibility under laser radiation. The problem will be simplified if one considers only macromechanisms of breakdown, and strongly nonlinear processes, with the breakdown threshold laser intensity as the only random variable. Several methods are available for theoretical analysis and for interpretation of experimental data. One may consider an axisymmetric laser beam with some given divergence angle in the material and, depending on the assumed intensity distribution (usually uniform or supergaussian), select the appropriate parameter or coordinate relative to the caustic as the random variable whose probability density function is sought. The analysis is refined by recognition that there are more than one (at least two) groups of defects in a material, each characterized by different concentration and threshold laser radiation intensity, in which case it is best to assume a Gaussian laser beam for determining the probability of breakdown as a function of not only laser radiation intensity but also laser beam focusing. This basic statistical approach, with further refinements such as inclusion of micromechanisms, has been used for interpretation of experimental data. Particularly extensive are experimental data on breakdown of GaAs, NaCl and KCl crystals by radiation from a CO_2-laser (λ =10.6 μm) obtained in a number of studies. Figure 1, references 14: 12 Russian, 2 Western.
[232-2415]

UDC 621.378

LASER GENERATION OF STRONG SHOCK WAVES

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1081-1089

ANISIMOV, S. I., PROKHOROV, A. M. and FORTOV, V. Ye., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Laser generation of kilojoule-terawatt shock waves, for controlled thermonuclear fusion, has been studied both theoretically and experimentally on the basis of conventional dynamical physics. Here the feasibility of using lasers in high-pressure dynamical physics for producing megabar pressures is reviewed. One important problem is determining the equation of state and other thermodynamic characteristics of superhigh-density plasma theoretically as well as by utilization of available experimental data. Asymptotic models in combination with semiempirical ones, statistical or quasi-statistical methods of calculation, and phase diagrams are considered for determining the properties of various gases, liquids and crystals under high pressure, the physical properties of plasmas being generally characterized by the nonideality parameter. Rough estimates have been made in the one-dimensional approximation with local absorption of light, aided by experiments under conditions of absorption resonance, and various simulation programs have been developed. Criteria and constraints have been established for designing targets and shaping laser pulses. Experiments have been set up and performed for diagnostic purposes, measuring any two of the fundamental five parameters that characterize propagation of steady plane shock discontinuities (phase velocity, group velocity, pressure, density, energy) and then calculating the other three on the basis of conservation laws. The indications are that record high energy concentrations can be attained with modern lasers and that this technique can be very effective in applications requiring extremely high pressures, temperatures, and velocities. Figures 2, references 36: 18 Russian, 18 Western.
[232-2415]

UDC 535.34

THERMOPHYSICAL PROCESSES DURING INTERACTION OF LASER RADIATION AND ABSORBING MEDIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1018-1025

RYKALIN, N. N. and UGLOV, A. A., Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences

[Abstract] Thermophysical processes occurring during interaction of laser radiation and an absorbing medium are examined theoretically, with the aid of

some experimental data obtained at the Institute of Metallurgy. First the authors consider the nonlinear problem of a stationary laser heating a thick metal plate, without phase transitions and chemical reactions at the surface. The corresponding equation of heat conduction, with negligible losses due to convection and radiation, is solvable by either numerical or approximate analytical methods, taking into account that the initial temperature changes. Then an examination is made of ablation, through melting and evaporation, and self-oscillations in the vapor stream leaving the body surface and describable by an expression that reduces to a Van der Pol equation. Gas-dynamic processes involved in laser-plasma treatment of materials, including breakdown of dense gas and formation of plasmoids as well as other interdependent short process, are difficult to analyze. Mathematical models have been constructed and solutions obtained by numerical methods, in collaboration with V. I. Mazhukin and B. N. Chetverushkin (Institute of Problems of Mechanics, USSR Academy of Sciences), for optical breakdown of nitrogen. Two other areas of interest are synthesis and reduction of materials from laser plasma. Experiments have been performed and progress made here, typical examples being synthesis of nitrides and carbides and reduction of tungsten oxide to metallic tungsten. Figures 4, references 28: 27 Russian, 1 Western.
[232-2415]

UDC 621.385.6

NEW METHOD OF STIMULATING DIFFRACTION EMISSION OSCILLATOR-FREE ELECTRON LASER

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 265, No 2, Jul 82
(manuscript received 25 Nov 81) pp 318-321

YEVDOKIMENKO, Yu. I., LUKIN, K. A., REVIN, I. D., SKRYNNIK, B. K. and SHESTOPALOV, V. P., academician, UkSSR Academy of Sciences, Institute of Radio Physics and Electronics, UkSSR Academy of Sciences, Kharkov

[Abstract] Until recently it had been assumed that diffraction emission oscillator-free electron lasers (DEO-FELs) were typified by one-to-one correspondence between the frequency of stimulated emission and initial electron velocity at fixed parameters of the electrodynamic system (open resonator, diffraction grating, beam hole). It has now been found that oscillations may be observed in the DEO-FEL on the same frequency with excitation of the same open resonator mode for appreciably different initial electron velocities. This effect is due to the peculiarities of a new mechanism of DEO-FEL excitation, and it arises in the case where the phase of the field changes stepwise in the direction of motion of electrons. The electrodynamic system of the DEO-FEL is an open resonator with astigmatic mirrors of rectangular aperture. The electromagnetic energy is coupled out to the load through a beam hole in one of the mirrors. A flat electron beam moves over a diffraction grating fixed in the central part of the other mirror. The high-Q modes of such a cavity differ in frequency and have a complex spatial

field structure approximated by Gauss-Hermite functions. In this paper the authors analyze excitation of the TEM_{01q} mode in the resonator, which is called the first mode of the DEO-FEL open cavity. The spatial structure of this mode is such that there are two spot fields along the direction of electron motion. The oscillations in these spots are 180° out of phase. Analysis of interaction of the electron flux with the field of the first mode of the cavity shows that there are two mode amplification zones where self-oscillations may be excited. These zones are separated by a region of absorption. The efficiency of interaction between the electron flux and the field of the first mode is characterized by the parameter of desychronism $\phi = (\frac{\omega}{v_0} - \frac{\omega}{v_{ph}})w$, where ω is the frequency of stimulated emission, w is the diameter of the spot field of the fundamental mode of the cavity, v_0 is initial electron velocity, and v_{ph} is the phase velocity of the spatial field harmonic that is synchronous with the electron flux when a plane homogeneous wave is normally incident on the diffraction grating. Near the natural frequency of the first mode, there is a change in the frequency of oscillations in both amplification zones. For values of ϕ from the different amplification zones (which is equivalent to different values of the initial electron velocity) the frequency of stimulated emission is the same. Figures 3, references 5: 4 Russian, 1 Western.
[252-6610]

MAGNETOHYDRODYNAMICS

UDC 621.313.12:538.4

OPTIMUM OPERATING CONDITIONS FOR DETONATION MHD-GENERATORS

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 3, May-Jun 82 (manuscript received 20 Jun 81) pp 584-586

MINTSEV, V. B. and FORTOV, V. Ye., Moscow

[Abstract] Detonation MHD generators with shock compressed argon, xenon, and air plasma as working substance can produce pulses of 10 MJ energy and 10^{-6}-10^{-3} s, this plasma being generated behind the front of strong shock waves (velocity D in the 5-100 km/s range) formed by detonation of an explosive substance. A performance analysis based on the electrical circuit has yielded the optimum conditions for energy delivery to a resistive load, the determining parameters being $\gamma = L/(R_P + R_L)$ (L- rate of change of inductance, R_P- resistance of plasmoid, R_L- resistance of external load). This parameter depends on the magnetic Reynolds number Re_{mag} thickness of the conducting piston 1 and effective depth of the current layer in the plasma $\delta \leq 1$, namely $\gamma = (1- k)Re_{mag} \delta/1$ $(k=R_L/R_P+R_L))$. The appropriate circuit and performance equations can be solved analytically for the case of constant D, L, Rp and R_L. Parameters of shock-compression plasma were calculated by simultaneous solution of hydrodynamic and thermodynamic equations, with the aid of tabulated values. The electrical conductivity was calculated in the additive approximation, with the use of cross sections for electron scattering by atoms and with nonideality of plasma due to Coulomb interaction accounted for in the Debye approximation. Performance curves were plotted showing the ratio of energy in the resistive load to energy of the initial magnetic field as a function of the velocity of shock waves at various initial pressures. The authors thank Ye. F. Lebedev and V. Ye. Ostashev for helpful discussions. Figures 2, references 15: 13 Russian, 2 Western. [230-2415]

UDC 621.313.12:538.4

MHD-GENERATORS USING SATURATED VAPORS OF ALKALI METALS

Moscow TEPLOFIZIKA VYSOKIKH TEMPERATUR in Russian Vol 20, No 3, May-Jun 82
(manuscript received 21 May 81) pp 565-572

BIBERMAN, L. M., LIKAL'TER, A. A. and YAKUBOV, I. T., Institute of High Temperatures, USSR Academy of Sciences

[Abstract] The feasibility of an MHD generator with nonideal plasma of alkali metals (K, Cs) as working fluid is analyzed from the standpoint of Rankine cycle thermodynamics and electrical properties. The electrical conductivity is anomalously high, according to the Saha equation for a quasi-neutral plasma of cesium vapor, and moreover proportional to the saturation pressure cubed. With a small fraction of liquid phase throughout the expansion process, the electrical conductivity should remain high. With the channel walls at saturation temperature, there should be no low-conductivity regions near the electrodes. Also the Hall number is low in a magnetic field of realistic intensity. The flow through such an MHD channel can be optimized and the MHD generator designed on the basis of the equations of motion, energy, and thermodynamics with the empirical temperature dependence of saturation pressure $p=\frac{C}{\sqrt{T}}\ e\ -q_0^{RT}$ ($q_0=$ 0.78 eV/atom for cesium and 0.89 eV/atom for potassium). Performance calculations for maximum upper cycle temperature of 1800 K, Mach number 0.5, and magnetic induction of 4 T yield an output power of 400 MW for cesium and 250 MW for potassium at cycle efficiencies of 55 and 50% respectively. The authors thank A. Ye. Sheyndlin and Ye. M. Shelkov for valuable discussions that have stimulated further elaboration of some problems. Figures 5, table 1, references 20: 17 Russian, 3 Western.
[230-2415]

NUCLEAR PHYSICS

REDUCING ENERGY LOSSES IN CHARGED-PARTICLE BEAM PASSING THROUGH MEDIUM

Moscow ZHURNAL EKSPERIMENTAL'NOY I TEORETICHESKOY FIZIKI in Russian Vol 82, No 6, Jun 82 (manuscript received 17 Dec 81) pp 1780-1788

NAMIOT, V. A.

[Abstract] Roughly speaking, there are two components of energy loss in a charged-particle beam passing through a material: one due to collisions of beam particles against material particles and a "collective" one due to buildup of oscillations. Although evidently the energy loss can never be smaller than the collision component alone, since "collective" processes in a medium at thermodynamic equilibrium theoretically tend to lower the beam energy, situations can occur where the energy loss is smaller. Such a situation is that of a nearly monochromatic beam with a certain mode of current modulation. This is demonstrated by taking into account periodic pressure fluctuations that occur during collisions and are in some way phase-locked along the entire parth of the beam. While collisions generate heat and the latter builds up a beam wave, these pressure fluctuations can also generate waves. As a result, some of the energy lost may be returned to the beam so that the total energy loss per collision becomes smaller rather than larger for a modulated beam than for an unmodulated one. This self-recuperation mechanism is analyzed here in the linear approximation and assuming constant velocity of beam particles. The equations of kinetics in the velocity and temperature fields are solved first for a boundless plasma of infinitely heavy ions containing an electron beam whose density is a periodic function of one space coordinate only, then for such a plasma containing a modulated beam and placed in a uniform magnetic field parallel to another space coordinate. The self-recuperation coefficient is calculated in each case, also in the practical case of a gaseous target filling an array of acoustic resonator cavities coupled through inductances. The author thanks G. A. Askar'yan and Ye. A. Romanovskiy for helpful discussions. Figure 1, references 10 Russian.
[233-2415]

UDC 621.384.66

USE OF HELICALLY SECTORAL MAGNETS FOR COLLECTING FLAT PARTICLE BEAMS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 6, Jun 82
(manuscript received 2 Jun 81) pp 1224-1226

DZERGACH, A. I.

[Abstract] Anisotropic focusing of particle beams for particle accumulators, with preferential attraction to the median plane, is possible by means of helically sectoral cyclotron magnets. Focusing a straight flat beam is an extreme application of such a magnet system. Weaker radial focusing allows widening the beam and, with the radial Coulomb forces thus weakened, increasing the number of collectable monoenergetic particles. This number is limited principally by the Coulomb frequency shift of free betatron oscillations, which depends on the charge distribution over the beam section. Calculations based on the potential in a uniformly charged elliptical cylinder, assuming long particle clusters, yield the advantage of magnets producing a flat beam over conventional magnets. Addition of special focusing magnets that produce an oblique periodic field facilitates providing long straight gaps. An analysis of the ballistics of a flat particle beam through such a system involves solution of the Matthieu equation for the region adjacent to the median plane. Typical characteristics of a proton accumulator are: kinetic energy 600 MeV, pulse dispersion 0.15%, mean orbit radius 6 m, intensity of twisting magnetic field 1 T, maximum gradient of magnetic field intensity 10 T/m, betatron frequencies 0.3-0.4 and 3, aperture of vacuum chamber 1.1x0.1 m, weight of magnet 2000 t, magnet supply power 1 MW. The author thanks A. A. Kuz'min and R. A. Meshcherov for support, Ye. L. Burshteyn for helpful discussions, and G. A. Radzin'sh for performing calculation on a computer. References 8 Russian.
[235-2415]

UDC 535.417.1

USE OF HOLOGRAPHIC DIFFRACTION GRATING FOR DEFLECTION OF LASER BEAM

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 53, No 1, Jul 82
(manscript received 17 Nov 80) pp 135-140

KISELEV, N. G.

[Abstract] Characteristics of holographic diffraction gratings as devices for deflecting a laser beam are analyzed on basis of geometrical relations that determine the change of path as a function of the rotation angle. Two special cases of diffraction gratings on plane substrates in air are considered, with the illuminating beam arbitrarily oriented relative to the axis of rotation. In the first case the substrate is arbitarily oriented relative to the axis of rotation but the grating lines are orthogonal to the latter. In the second case the grating lines lie in a plane through the axis of rotation. Both a transmission grating and a reflection grating are examined in each case, the former more difficult to synthesize with conventional optics but yielding a holographic deflectogram with stepwise displacement of the scanning spot, the latter yielding a nonlinear deflection law but suitable for wide deflection angles and high scan frequencies. The performance characteristics of a beam deflector are calculated on this basis and a transmission grating with the substrate orthogonal to the axis of rotation is found to be most promising for this application, combining linearity of the deflection characteristic with near rectilinearity of hologram lines. Figures 4, references 7: 1 Russian, 6 Western.
[239-2415]

UDC 535.818.8

METHOD OF ANALYZING WAVE ABERRATION IN TWO-COMPONENT HOLOGRAPHIC OBJECTIVE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 53, No 1, Jul 82
(manuscript received 23 Dec 80) pp 130-134

SHITOV, V. G., GREYSUKH, G. I., VANIN, V. A. and BUTUSOV, M. M.

[Abstract] A holographic objective converting a divergent wave front to a convergent one is considered which, instead of having an expensive wide

aperture, consists of two parallel oppositely oriented hologram lenses. Holograms are recorded with a spherical wave front from the source and a plane reference wave front, the first hologram restoring an exact copy of the reference wave front and, if that copy is complex conjugate to the reference wave front, it forms an undistorted convergent wave front on the second hologram. The dependence of the wave aberration on the curvature of the reference wave front is calculated by the method of paths, from the fundamental equation of holography for the complex amplitude of wave fronts that can be reconstructed in one of the diffraction orders. On this basis, the image quality indicator is evaluated as a function of reference wave front curvature and also as a function of the distance between lenses. The results, verified by numerical simulation on a computer, reveal that high fidelity requires a reference wave front with large radius of curvature and a point source, if such is used, at a far distance from the objective. Figures 3, references 6: 5 Russian, 1 Western.
[239-2415]

UDC 535.317.1

FILTRATION OF IMAGES NOT SPACE-INVARIANT WITH RESPECT TO ATMOSPHERIC DISTORTIONS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 52, No 6, Jun 82
(manuscript received 26 May 81) pp 1076-1079

BAKUT, P. A., SVIRIDOV, K. N. and KHOMICH, N. Yu.

[Abstract] A method is proposed for space filtration of images not space-invariant with respect to atmospheric distortions, namely by dividing such an image into N subimages dimensionally comparable with the isoplanarity region in the atmosphere-telescope system and thus into N independent regions within each of which the system remains space-invariant. The method involves application of the convolution theorem and Fourier transformation, which yield a description of these subimages in the space-frequency domain, followed by further division of each subimage into M fragments corresponding to the number of resolution elements of the system within the isoplanarity region. Restoration of an undistorted diffraction-limited image is then effected by inverse filtration of the space spectra of all subimages and subsequent inverse Fourier transformation. References 7: 3 Russian, 4 Western.
[229-2415]

UDC 621.373:535

WAVEFRONT REVERSAL IN FOUR-WAVE MIXING IN AMPLIFYING MEDIUM OF Ar$^+$-LASER

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 52, No 6, Jun 82
(manuscript received 13 Apr 81) pp 1065-1067

BYKOVA, N. G., LEBEDEVA, V. V. and ODINTSOV, A. I.

[Abstract] Wavefront reversal during degenerate four-wave mixing in the active medium of a CW Ar$^+$-laser has been found to be theoretically possible at the $4p^2D_{5/3} - 4s^2P_{3/2}$ transition ($\lambda = 488$ nm). Optimum conditions for experimental verification have also been established, based on dependence of the reflection coefficient on attenuation, on frequency deviation from resonance and on the ratio of pumping power to saturation power at the center of the resonance line. The equipment consisted of a 1.7 m long resonator with concave spherical mirrors (radii 4 and 5 m, reflection coefficients 99 and 92% respectively) forming a Gaussian TEM$_{00}$-mode beam with minimum divergence, a quartz prism, and a Trotskiy absorbing film for mode selection. The frequency in one-frequency operation was tuned within the resonance line by means of a piezoceramic corrector and monitored by a Fabry-Perot interferometer. A third mirror (radius 1.5 m) formed a test beam. Phase coupling of the reflected signal at a certain magnitude of attenuation was indicated by its small divergence and by high sensitivity of its intensity to tuning of the system. Figures 2, references 11: 5 Russian, 6 Western.
[229-2415]

UDC 535.317.1+535.42+535.36

DIFFRACTION EFFICIENCY OF HOLOGRAM RECORDED THROUGH TURBID MEDIUM

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 52, No 6, Jun 82
(manuscript received 22 Nov 80) pp 1029-1033

PREDKO, K. G. and SINCHENKO, V. G.

[Abstract] An experimental study was made to determine the diffraction efficiency of holograms recorded through a turbid medium with variable optical properties, with the reference beam propagating outside that medium. Both object and reference beams had plane waves, propagated by 16° angle to one another, their intensities were varied by means of neutral filters and holograms were recorded on FN-GV2 film. Milk in various concentrations served as the scattering medium, nigrosine added to ensure absorption of light only. Processing of the holograms yielded the dependence of the degree of coherence on optical thickness of the medium and on photon survival probability as well as the dependence, in turn, of diffraction efficiency on degree of coherence. From these relations it was possible to establish the optimum ratio of object beam to reference beam intensities for maximum diffraction efficiency under various conditions in the turbid medium. Figures 2, references 11: 10 Russian, 1 Western.
[229-2415]

UDC 535.317.1:535.345.6

USE OF DIGITAL HOLOGRAPHIC FILTERS FOR OPTIMIZING METHODS OF COHERENT OPTICAL PATTERN RECOGNITION, PART 2: EXPERIMENTAL RESULTS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 52, No 6, Jun 82
(manuscript received 28 Jul 80) pp 1034-1039

GIRNYKH, V. I., KURASHOV, V. N. and NAKHODKIN, N. G.

[Abstract] Feasibility of optimizing coherent optical pattern recognition by synthesis of digital holographic filters in the Fourier plane and the basis of factor analysis was studied experimentally with the aid of a laser light plotter built at Kiev State University. The device consisted of a radiation source ($\lambda = 0.44$ µm), acoustico-optic modulator, two lenses and diaphragm between them for trimming and shaping a laser beam with Gaussian intensity distribution, a piezoceramic scanner for controlling the beam in space and an objective for focusing it on the surface of a movable recording medium. For monitoring the beam power, a beam splitter sends part of the output through optics to a photoreceiver with a measuring instrument. Focusing of the beam was controlled from an image of its light spot on a screen. Modulator and deflector were controlled from a computer. With 32 quantization levels and 64x64 hologram elements of 5 um size, holograms were recorded in 4 sec and their dimensions varied from 320-x320 to 1600x1600 μm^2 on Micrat LOI-2 hotographic plates and 6.5 µm thick photothermoplastic film on glass substrates. Effective performance of such filters was observed in terms of binary forrelation responses depending on the light plotter aperture, in recognition of three objects $S_k(r), k = 1,2..., K$ ($S_1=1$, $S_2= 5$, $S_3= 8$) through two different sets of matched filters with pulse responses $U_m(r), m= 1,2,...,M$ $M= K= 3$ and 3 and $M= \log_2(K+ 1)=2$). Figures 5, references 4: 2 Russian, 2 Western.
[229-2415]

UDC 535.317.1

PARAMETERS OF CORRELATION RESPONSES IN PROBLEMS OF OPTIMAL IMAGE FILTRATION

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 52, No 6, Jun 82
(manuscript received 6 Nov 80) pp 1040-1045

KOROLEV, A. N.

[Abstract] Correlation responses of six algorithms of pattern recognition by optimal image filtration are analyzed comparatively, each algorithm and corresponding filter being optimal under certain conditions and thus for certain applications only (matched filter, inversion filter, inversion filter with regularizer, matched-selective filter of the first kind, plain phase filter, gradient filter). Their frequency characteristics and corresponding weight functions as well as maximum magnitude of the correlation signal according to either are calculated, also half-width of correlation signal and signal-to-noise ratio. Figures 3, tables 1, references 7: 6 Russian, 1 Western.
[229-2415]

UDC 535.211.4

CHARACTERISTICS OF DETECTING INFRARED RADIATION THROUGH ITS INTERACTION WITH INDUCED GRATING IN OPTICAL WAVEGUIDE

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 6, Jun 82 (manuscript received 17 Jul 81) pp 1141-1150

BLACK, T. D., KOMOTSKIY, V. A. and NIKULIN, V. F., University of Peoples' Friendship imeni Patrice Lumumba

[Abstract] The method of detecting infrared radiation with a plane optical waveguide and an interference mask above it is evaluated, a grating being induced on the waveguide film by incident radiation upon passage of the latter through the mask while a surface acoustic wave of wavelength equal to the grating period is excited and propagates transversely over that grating. Upon interaction with both the induced grating and the surface acoustic wave, the incident optical wave becomes space phase modulated before it enters the detector (photoiode in series with a load resistor across d.c. voltage source shunted by a capacitor). Detectability thresholds are determined by noise in the detector circuit (thermal and shot) as well as by amplifier noise and noise bandwidth of the recording channel). The sensitivity of this method depends on the film thickness and temperature. The temperature field in the waveguide is therefore calculated, assuming cosinusoidally distributed density of absorbed infrared power, and sensitivity of the detector is calculated from the thresholds and its response speed is calculated from the pulse rise time and the relaxation time. Numerical values obtained for waveguide film of polymethyl methacrylate on BaF_2 or SrF_2 substrates, or on Si substrate with SiO_2 interlayer, indicate that both power sensitivity ($W/cm^2 \cdot \sqrt{Hz}$) and energy sensitivity ($J/cm^2 \cdot \sqrt{Hz}$) can be improved by optimization of energy absorption and transmission in the system. Figures 6, tables 2, references 4: 2 Russian, 2 Western.
[235-2415]

UDC 621.378.46

OPTIMUM CONTROL OF WAVE FRONT AND TIME PROFILE OF OPTICAL RADIATION PROPAGATING IN NONLINEAR MEDIUM

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA, SERIYA 3: FIZIKA, ASTRONOMIYA in Russian Vol 23, No 4, Jul-Aug 82 (manuscript received 19 Oct 80) pp 18-21

KARAMZIN, Yu. N., SUKHORUKOV, A. P. and TROFIMOV, V. A., Department of General Physics and Wave Processes, Moscow State University

[Abstract] When optical beams are used for data transmission, the beams must be shaped so that nonlinear distortions are minimized as they travel through nonlinear media. Conventional methods of optimizing beam parameters generally

require the use of a computer. The required beam parameters can be found most rapidly in the first approximation by using an aberrationless description of the process of optical propagation in a nonlinear medium in which the beam is characterized by only by its dimensionless width. This paper gives an algorithm for realization of the proposed technique in application to media with various mechanisms of nonlinearity for cases of steady and unsteady propagation of optical radiation. Results are given for optimization of pulse shape and wave front for various pulses. The same technique is applicable to analysis of problems of optimizing the slope of the phase front in the case of propagation in a moving medium, as well as pulse shape in the case of unsteady Kerr nonlinearity. Figures 2, references 5 Russian.
[253-6610]

UDC 778.4:534-8

WAVE AMPLIFICATION AND PARAMETRIC STIMULATED EMISSION ON PLANE DYNAMIC HOLOGRAMS

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 265, No 2, Jul 82
(manuscript received 17 Dec 81) pp 324-327

PILIPETSKIY, N. F., SUDARKIN, A. N. and SHKUNOV, V. V., Institute of Problems in Mechanics, USSR Academy of Sciences, Moscow

[Abstract] Recent research on wavefront reversal by an interface has drawn attention to the problem of light beam and sound beam transformation by dynamic holograms recorded on a reflective surface. The authors discuss problems of dynamic correction and amplification of beams by using holograms of this type, and also analyze the feasibility of using such holograms to develop a parametric device for stimulated emission of highly directional acoustic and optical waves. It is assumed that a strong reference wave and a weak signal wave are incident on a flat reflective surface with amplitude reflectance r'(I) that depends on the intensity of radiation. Upon reflection from the surface with recorded hologram, the reference wave is rescattered in the zero and first diffraction orders. The wave corresponding to the term representing the first diffraction order on the holographic grating propagates in the direction of the signal reflected from the surface for any orientation of the reference wave. It is shown that if amplitude reflectance is a sufficiently sharp function of intensity, the reflected signal may be amplified by energy transfer from the reference wave. A parametric device for stimulated emission of highly directional waves is proposed with pumping by an intense divergent reference wave. This wave generator consists of a cavity containing an angle selector and a nonlinear surface illuminated by the reference wave. Intracavity amplification is provided by a hologram that is recorded on the nonlinear surface by the wave being generated with the reference wave. Acoustic waves are produced by excitation on a liquid surface. Figures 2, references 12: 8 Russian, 4 Western.
[252-6610]

UDC 522.2

FIRST RESULTS OF COMPUTERIZED TWO-COORDINATE MACHINING OF OPTICAL SURFACE

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 265, No 2, Jul 82
(manuscript received 21 Dec 81) pp 328-330

VITRICHENKO, E. A., GORELIK, V. V., YEVSEYEV, O. A., IRTUGANOV, Sh. Sh., MALYKHIN, V. A., NEKRASOV, V. V., PROKHOROV, A. M., academician, REBROV, A. V., SAVEL'YEV, A. V. and TRUSHIN, Ye. V., Institute of Space Research, USSR Academy of Sciences, Moscow

[Abstract] The paper gives the results of the first industrial tests of the ZEBRA-2 Soviet system for computer-controlled machining of large optical surfaces with correction of local errors. The testing was done on final lapping of a plate 433 mm in diameter and 40 mm thick made of grade KV fused quartz. The work was done in four stages with a total time of 7 hours and 40 minutes. Interference patterns taken before and after correction show that both flat surfaces were of high quality before final lapping, but the internal inhomogeneities of the material caused deviations from uniformity of the index of refraction. Transmission properties were considerably improved by correction. The rms error of the wavefront transmitted before correction was 0.038 μm, and was 0.028 μm after correction for a wavelength of 0.63 μm, i. e. an improvement from 0.060 to 0.044 wavelength. Figures 3, references 5: 2 Russian, 3 Western.
[252-6610]

UDC 621.397.3

DEVICE FOR OBJECT IDENTIFICATION THROUGH OPTOELECTRONIC PROCESSING OF IMAGES

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian
No 3, May-Jun 82 (manuscript received 17 Jun 81) pp 180-181

MINCHEV, G. G., ILIYEVA, M. G., PEKHLIVANOV, Kh. N., FURNADZHIYEVA, M. V.
and BOZHKOV, T. G., Sofia, Bulgaria

[Abstract] A device is proposed for fast and reliable processing of images for object identification. For a typical application, where the input objects are letters and digits of standard print, the device consists of five optical receptors in parallel with a normalizing circuit followed by a logical analyzer. Each receptor has one input and four outputs, the latter corresponding to four relative threshold energy levels of input signals established by preliminary experiment and refined through calibration. Each receptor consists of a photoconverter, an amplifier, and three comparators in parallel determining into which of three preselected ranges a signal falls. The logic analyzer processes the output from all receptors and the normalizing circuit, tests the combination of images, and produces the appropriate symbol in 5-digit 3-range (28 letters of the Russian alphabet) code for display or further computer processing. Figures 2, table 1, references 3: 2 Russian, 1 Bulgarian.
[231-2415]

UDC 535.317.1

A POSTERIORI SPACE FILTRATION OF SHORT-EXPOSURE IMAGE DISTORTED BY ATMOSPHERE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 53, No 1, Jul 82
(manuscript received 8 Jun 81) pp 163-166

BAKUT, P. A., SVIRIDOV, K. N., SIDEL'NIKOV, V. N. and USTINOV, N. D.

[Abstract] A short-exposure image of an object taken by a telescope is distorted by a turbulent atmosphere, as is a long-exposure image, but a posteriori space filtration becomes in this case difficult because of the momentary transfer function of the "atmosphere-telescope" system being a complex random one

not describable by a universal analytical relation. The problem is formulated here as that of finding an approximation of either the random pulse response with the mean optical transfer function known or an approximation of the mean optical transfer function with the random pulse response known. The problem can be solved by statistical processing of spatial spectra of recorded image fragments and in this way reconstructing both modulus and phase of the transfer function and thus also those of the pulse reponse. Calculations are based on invariance of the system with respect to image fragments larger than its resolution elements and are done by an iteration procedure with Fourier and inverse Fourier transformations. A deviation of the initially selected first approximation from the mean transfer function will result in negative intensities in the inverse Fourier transform and these must be reduced to zero. This can be done by first adjusting the modulus with the phase fixed or first adjusting the phase with the modulus fixed and then changing respectively the phase or the modulus from step to step, depending on which has been determined more accurately in the preceding step. References 2 Western.
[239-2415]

UDC 537.533.33

EXPERIMENTAL STUDY OF ISOLATED SIMPLE BIPLANAR LENS, PART 2: ABERRATION CHARACTERISTICS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 6, Jun 82 (manuscript received 20 Jul 81) pp 1226-1228

AFANAS'YEV, V. P. and SADYKIN, A. D., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] The spherical aberration of an isolated simple biplanar lens in vacuum was measured on an electron-optical bench by a two-grid method. Both screen grid and cathode grid could be moved in two mutually orthogonal directions and rotated about the optical axis of the system without disturbing the vacuum. The two parallel plates of the lens, made of Micarta foil, were square (40 mm) and 20 mm apart, the two inner electrodes were 18 mm wide, the two outer electrodes were 4 mm wide, all electrodes were 29 mm long. With the accelerating potential equal to 2.5 kV, the potential of the inner electrodes was varied in 1-0 or 200 V steps and the potential of the outer electrodes was matched so as to maintain a constant focal length. Linear images of point objects were obtained between lens and screen grid. The aberration coefficient in the focusing plane and in the scattering plane was determined at various focal lengths and various combinations of electrode potentials. The results indicate that this aberration coefficient can, at any given focal length, be controlled electrically over a wide range, also be made negative and reduced to zero. Figure 1, table 1, references 2 Russian.
[235-2415]

UDC 537.533.2

EXPERIMENTAL STUDY OF ISOLATED SIMPLE BIPLANAR LENS, PART 1: FOCUSING CHARACTERISTICS

Leningrad ZHURNAL TEKHNICKESKOY FIZIKI in Russian Vol 52, No 6, Jun 82 (manuscript received 12 Mar 81) pp 1213-1215

AFANAS'YEV, V. P. and SADYKIN, A. D., Physico-Technical Institute imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] The simplest version of a biplanar lens, an isolated single-section lens, was studied experimentally for determination of its focusing characteristics. The lens consisted of two plates of Micarta foil, with two pairs of electrodes separated from one another and from the remainder of the plates by isolating grooves. Both electrode pairs were energized through a common voltage divider, the inner pair tapped to a point at potential V_1 and the outer pair tapped to a point at potential V_2. The unenergized remainder of the plates was grounded. Such a lens, just as a crossed or quadrupole one, forms a linear image of a point object by collecting a beam of charged particles in one of two orthogonal directions and scattering it in the other. In the experiment the inner electrodes were 18 mm wide and the outer electrodes were 4 mm wide, all electrodes being 29 mm long, the two parallel plates were square (40 mm) and 20 mm apart. The accelerating potential was 3200 V. The potential of the inner electrodes was held constant at various levels while the potential of the outer electrodes was varied. The focal lengths were found to depend on the ratio of each electrode potential to accelerating potential, with either real or virtual images formed. At a certain ratio of potentials V_1 and V_2 the focusing plane and the scattering plane switch locations. The results of measurements indicate that such a lens has twice the optical power of a crossed lens and an only slightly lower optical power than a quadrupole one. The authors thank V. M. Mikhin for assisting with the experiment. Figures 4, references 2 Russian.
[235-2415]

UDC 537.533.34

OPTOELECTRONIC SYSTEM BASED ON CYLINDRICAL AND SPHERICAL ELECTROSTATIC MIRRORS

Leningrad ZHURNAL TEKHNICHESKOY FIZIKI in Russian Vol 52, No 8, Aug 82 (manuscript received 8 Oct 81) pp 1633-1636

ZASHKVARA, V. V. and ASHIMBAYEVA, B. U., Institute of Nuclear Physics, KaSSR Academy of Sciences, Alma-Ata

[Abstract] A combination optoelectronic system of two electrostatic mirrors of cylindrical type and another of spherical type has been studied in previous research for the case where the charged particle beam penetrates into

the region of the spherical field through the outer spherical electrode (exterior reflection of the beam from the spherical mirror). In this paper, the authors analyze the optoelectronic and time-of-flight characteristics of an analogous system in which the charged particle beam enters the spherical field region through the inner spherical electrode (interior beam reflection from the spherical mirror). The initial equations for the analysis are expressions for the projection of a segment of an arbitrary trajectory from source to image on the axis of symmetry of the system, and for the time of flight of a charged particle along this trajectory. It is found that the system has the following major properties when operating in the mode of zero linear dispersion with respect to energy. 1. A beam of charged particle from a point source is focused on the axis of symmetry with accuracy to the cube of the angle of divergence inclusive. Cubic aberration changes sign near the point of angular focusing of third order. This property permits the system to be used for compensation of both positive and negative cubic aberrations in electrostatic energy analyzers. 2. Considerable angular dispersion. The system could be a high-resolution energy analyzer with low angular divergence of the beam in the axial plane for simultaneous registration of spectra in a finite energy interval by a coordinate detector. The trajectories of a beam of charged particles with the same energy and mass are isochronous in the first approximation with respect to the angle of divergence of the beam. At large values of the ratio of the radius of the inner spherical electrode to that of the inner cylindrical electrode, the dispersion of time of flight with respect to energy is reducible to zero. Thus the proposed system can be used for time-of-flight analysis of charged particle beams. Figures 3, table 1, references 3 Russian.
[254-6610]

UDC 533.951.2

DYNAMICS OF HARMONIC GENERATION IN LASER PLASMA

Moscow FIZIKA PLAZMY in Russian Vol 8, No 3, May-Jun 82 (manuscript received 6 Apr 81) pp 600-606

ANDREYEV, N. Ye., SILIN, V. P. and STENCHIKOV, G. L., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Generation of time harmonics of glow discharge in a laser plasma is due to nonlinear processes in the vicinity of critical density at which absorption of the electromagnetic field occurs, especially in the case of obliquely incident p-polarized laser radiation. An analysis of the dynamics of harmonic generation, specifically generation of the second and the third, on the basis of Maxwell field equations with appropriate boundary conditions for reflection yields the coefficients of frequency conversion and their variation in time. Calculations were done for an initial plasma density profile corresponding to a rarefaction wave, in one case of an initially quiescent plasma where the flow of gas near the critical plasma density remains subsonic, and in another case of an initial plasma velocity profile varying linearly in space where the flow of gas near the critical plasma density becomes supersonic. Equations of hydrodynamics were used in the calculation, also experimental data on heating a plasma with a Nd-laser. Figures 4, references 12: 9 Russian, 3 Western.
[236-2415]

UDC 533.932

CHARACTERISTICS OF SPACE-TIME EVOLUTION OF OVERHEATING-IONIZATION INSTABILITY

Moscow FIZIKA PLAZMY in Russian Vol 8, No 3, May-Jun 82 (manuscript received 3 Jun 81) pp 561-564

KOROLEVA, I. L., NAPARTOVICH, A. P. and STAROSTIN, A. N., Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] Filamentation of glow discharge by the universal mechanism of overheating-ionization instability, namely sharp increase of ionization rate and of plasma density at decreasing gas density with attendant heating, is

analyzed on the basis of numerical solution of the coresponding equations of gas dynamics with heat conduction and ambipolar electron diffusion taken into account. The one-dimensional model of ribbon discharge uniform along the current path is considered here, such a discharge being generally used for pulse pumping of laser media. Calculations were made for nitrogen, but assuming a relaxation time for the internal molecular energy much shorter than the filament buildup time, and consequently, no time delay in conversion of all electric energy to heat. The boundary conditions were zero gradients of gas velocity, gas density, energy density, electron concentration at the center and zero gas velocity and electron concentration at the wall. The initial conditions were room temperature (300 K) and atmospheric pressure. The results obtained for various ratios of electric field intensity to gas concentration reveal that, as this parameter increases from $5.5 \cdot 10^{-16}$ to $8.5 \cdot 10^{-16}$ $V \cdot cm^2$ and the filamentation buildup time becomes corespondingly shorter than the sound travel time, this instability shifts from the narrow central region of initial plasma density perturbation toward the peripheral region at the wall. This is evident from the transverse profiles of gas velocity, gas temperature, and electron concentration. Figures 3, tables 1, references 10: 7 Russian, 3 Western.
[236-2415]

UDC 537.525.99

STABILITY OF COMPOUND DISCHARGE MAINTAINED BY CONSTANT AND HIGH-FREQUENCY ELECTRIC FIELDS, PART 1: STRUCTURAL PECULIARITIES OF HIGH-CURRENT HIGH-FREQUENCY CAPACITIVE DISCHARGE

Moscow FIZIKA PLAZMY in Russian Vol 8, No 3, May-Jun 82 (manuscript received 3 Nov 80, after correction 20 Apr 81) pp 543-549

MYSHENKOV, V. I. and YATSENKO, N. A., Institute of Problems in Mechanics, USSR Academy of Sciences

[Abstract] A study is made of the stability of discharge simultaneously maintained by a constant electric field and a high-frequency one. The high stability of such a discharge is found to be due to its structural peculiarities. Theoretical analysis of high-current high-frequency capacitive discharge and experimental data on discharge in various gases (air, CO_2, He) reveal high-conductivity zones at the high-frequency electrodes, where the electrical conductivity is much higher than in the plasma column, and also that continuous oscillation of the electric field intensity in the plasma column plays a subordinate role. This is explained by ambipolar diffusion of electrons into the Faraday space and their annihilation during dissociative recombination with molecular ions such as He_2^+, just as in a plain d.c. glow discharge, as well as by a possibly appreciable effect of the electron beam on the structure of the Faraday space under the given conditions. Any differences between compound discharge and plain d.c. glow discharge can also be easily explained on the basis of this model. References 9: 6 Russian, 3 Western.
[236-2415]

UDC 533.922

PLASMA HEATING BY BEAM OF HEAVY IONS

Moscow FIZIKA PLAZMY in Russian Vol 8, No 3, May-Jun 82 (manuscript received 13 Jan 81, after correction 28 Oct 81) pp 519-528

BASKO, M. M. and SOKOLOVSKIY, M. V., Institute of Theoretical and Experimental Physics

[Abstract] Heating of a plasma by a heavy-ion beam along its path toward a thermonuclear target is analyzed on the basis of the Coulomb mechanism of ion retardation according to classical energy transfer from individual ions to electrons of the ambient medium. This mechanism is shown to dominate slowdown in an electric field decompensating the electric charge of the beam at the plasma boundary during teardown of electron clouds around ions as well as collective retardation caused by beam instability resulting in plasma oscillations. The retarding force is calculated on the basis of well known kinetics, taking into account electron shells around ions and electron exchange with the ambient medium as well as transition from the "supersonic" ($V \ll \sqrt{T/m_e}$) to "subsonic" ($V \lesssim \sqrt{T/m_e}$) mode, then the rate of Coulomb energy loss is calculated considering three components of the retardation force: stopping at bound electrons of atoms and atomic residues, stopping at free charges of plasma, stopping at unshielded charges of nuclei. Experimental data have been obtained on the proton stopping power and the ion stopping power of various metals (Al, Cu, Ag) and dependence of this power on the proton or ion energy respectively in the range up to 10 MeV/amu. Model calculations were also made for U^{238} ions in cold lead, as starter, yielding the Coulomb range with an error not expected to exceed 15% taking into consideration temperature and ionization profiles in the target at various instants of time. The authors thank N. A. Bobrova, V. S. Imshennik and M. D. Churazov for helpful discussions. Figures 4, tables 1, references 21: 6 Russian, 15 Western.
[236-2415]

UDC 533.95:538.4

MHD-MECHANISM OF METAL ELECTRODE VAPORIZATION IN PLASMA FOCUS

Moscow FIZIKA PLAZMY in Russian Vol 8, No 3, May-Jun 82 (manuscript received 23 Feb 81) pp 487-501

GERUSOV, A. V., GINZBURG, S. L. and IMSHENNIK, V. S., Institute of Applied Mathematics, USSR Academy of Sciences

[Abstract] Vaporization of a metal electrode in a plasma with Z-pinch is analyzed in the one-dimensional approximation, based on a model of electron beam and anode surface interaction that includes not only acceleration of electrons and buildup of pressure inside the anode but also generation of x-rays. It also accounts for a predominant role of slow rather than fast

conduction electrons in the process. Heating and motion of liquid metal are described by a plane one-dimensional system of three MHD equations in Lagrange coordinates with initial conditions for metal in the normal state (zero velocity, room temperature, standard density) and boundary conditions at the metal plasma and deuterium plasma interface (constant external pressure $8.28 \cdot 10^9$ dyn/cm^2, zero thermal flux, deuterium temperature 10^7 K, deuterium charge concentration $3 \cdot 10^{18}$ cm^{-3}). The equations of state are formulated to encompass the two extreme states of solid metal and ideal metal vapor plasma. Both ionization energy loss and Joule effect heating are evaluated on this basis, inasmuch as both mechanisms may operate concurrently. Numerical calculations yield the profiles of density, temperature, pressure, velocity, and charge as well as the variation of these quantities and of the characteristic vaporization limits in time. They also reveal diffusion of the magnetic field into the anode, maximum current density at the lower edge of the skin layer, and maximum pressure with possibility of chipping during vaporization at the depth of magnetic field penetration. Secondary physical effects include electric fields in molten metal, sources of fast electrons in deuterium plasma outside molten metal, plasma nonideality and degeneracy, and additional radiation. Vaporization in the x-ray mode is characterized by abrupt separation of the surface layer of metal plasma. For this case the MHD equations and the equations of state should be solved with necessary adjustments and they generally yield lower bound estimates, available experimental data agreeing fairly well with theoretical results and confirming that velocity at the surface and pressure in the bulk are only slightly different for different anode materials (Cu, Al, W). The authors thank N. B. Volkov and V. F. D'yachenko for helpful suggestions with regard to formulation of the problem and method of its solution, also N. V. Filippov and N. N. Kalitkin for helpful discussions of the results. Figures 6, table 1, references 19: 18 Russian, 1 Western.
[236-2415]

UDC 533.9.15:537.52

SLOW IGNITION OF LASER PLASMA

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1141-1149

BUFETOV, I. A., PROKHOROV, A. M., FEDOROV, V. B. and FOMIN, V. K.

[Abstract] Slow ignition of a laser plasma, i.e., maintenance and subsonic propagation of a plasma through a gas in an optical-frequency field has been studied extensively, producing the initial absorption center being the main object of most experiments. A review of studies made by many authors during 1970-80, following the first observations of a laser arc in the slow-ignition mode (in 1969 at the Institute of Physics, USSR Academy of Sciences) is supplemented by a report on the results of studies made by these authors specifically. They studied motion of the gas through the discharge region,

using interaction of two separate optical discharges as means of monitoring the process. They also determined thresholds of discharge propagation through atmospheric air based on measurements of threshold power at zero velocity of the discharge front and of power absorbed for maintenance of discharge. While a CO_2-laser was used in many other studies, an Nd-laser had also been proposed and these authors used it in their studies. Figures 4, references 41: 31 Russian, 10 Western.
[232-2415]

UDC 535.21+621.378.33

PULSE HEATING OF METALS BY LASER PLASMA IN SUBSONIC AIR STREAM

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1058-1064

AGEYEV, V. P., GORBUNOV, A. A., KONOV, V. I., NIKITIN, P. I., SILENOK, A. S. and CHAPLIYEV, N. I., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] Pulse heating of metals by laser plasma in a subsonic air stream, with attendant expansion of explosion products to atmospheric pressure and their entrainment by the air shock wave, is analyzed on the basis of the "fire ball" model and experimental data. In the theoretical part the dimension of a "fire ball" is related not to the energy of a laser pulse but to the energy absorbed by the target outside the spot. In the experimental part low-threshold breakdown of air was triggered by irradiation of a disk (3.4 mm diameter) of AMtsM aluminum alloy at the center of a cylinder of thermally insulating material with a pulse-periodic TEA CO_2 laser emitting pulses of 0.1-0.5 J energy and 0.4 μs duration at a repetition rate of 80 Hz. The peak intensity at the center of the spot (0.12 cm radius) was varied from 6.5 to 32 MW/cm^2. Measurements were made with Chromel-Copel thermocouples and a loop oscillograph. The transient energy transfer from "fire ball" to target is evaluated on the basis of the corresponding model of energy distribution, with experimental data on target heating and cooling. The role of radiation is estimated on the basis of empirical relations for emissivity and radiative heat loss as functions of temperature and radius. The role of conduction is estimated in the one-dimensional approximation with a corrective term accounting for convection in the gas-dynamically perturbed state. Shadow photographs illustrate, qualitatively only, evolution of a "fire ball" with vortical or turbulent motion under a downward vertical laser beam and in a horizontal air stream above the target surface. Figures 5, table 1, references 9 Russian.
[232-2415]

UDC 535.21+621.378.33

BREAKDOWN OF AIR NEAR SOLID TARGET BY RADIATION FROM CO_2-LASER

Moscow IZVESTIYA AKADEMII NAUK SSSR: SERIYA FIZICHESKAYA in Russian Vol 46, No 6, Jun 82 pp 1044-1051

KONOV, V. I., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences

[Abstract] An experimental study was made of plasma formation in air near solid targets irradiated by a CO_2-laser. A pulsed TEA laser was used, first with short emission pulses (strong 200 ns leading peak + weak 2.5 ns tail) and a graphite target for spectroscopic analysis not yet fully interpreted, then with long quasi-triangular emission pulses (energy $E \lesssim 2$ J, duration $\tau \gtrsim 32$ μs) and mainly brass targets for measurement of plasma formation parameters such as plasma glow intensity. The irradiated spots were $\lesssim 1$ mm in diameter in each case. Readings of threshold glow intensity and of intensity changes accompanied by crater formation indicate plasma formation by vapor flare of target material rather than by optical breakdown of air. Data also indicate that moderate evaporation rates suffice for discharge of flares through various surface defects, in air just as in vacuum. The plasma nucleation centers cause optical breakdown of air only above the threshold intensity of 10^7 W/cm^2. This suggests that ionization of air follows breakdown of metal vapor, after the surface layer of target material has evaporated. Further evidence of such a mechanism are thin metal flakes found near the base surface thermally insulated from it. These conclusions are confirmed by quantitative analysis of electron avalanche and diffusion kinetics. Figures 5, references 18: 13 Russian, 5 Western.
[232-2415]

UDC 518.9

EXISTENCE OF EQUILIBRIUM SITUATIONS IN NON-COOPERATIVE DIFFERENTIAL MULTIPLAYER GAMES

Leningrad VESTNIK LENINGRADSKOGO UNIVERSITETA: MATEMATIKA, MEKHANIKA, ASTRONOMIYA in Russian Vol 13, No 3, Jul 82 (manuscript received 12 Feb 81) pp 40-46

MALAFEYEV, O. A.

[Abstract] A non-cooperative differential game with n players is considered, the dynamics of each player being defined by a generalized dynamic system $D_i(x_i, t)$ in a complete locally compact metric space (X_i, ρ_i) and that generalized dynamic system having been generated, for instance, by a controllable system $x_i = f_i(x_i, u_i)$ in a finite-dimensional Euclidean space R^{m_i} which satisfies standard constraints. The duration of the game is $T < \infty$. Each player uses piecewise-programmable strategies, his terminal payoff being defined by a continuous function $\bar{H}_i : X \rightarrow R^1$. The existence of equilibrium situations in such a non-cooperative $\Gamma(\cdot)$ game is proved with aid of five lemmas and a theorem pertaining to ε-equilibrium situations in an antagonistic $\Gamma^*(z_0, T)$ game, the set of ε-equilibrium situations of this $\Gamma(\cdot)$ game coinciding with the set of ε-optimum strategies of second player in an antagonistic $\Gamma^*(\cdot)$ game. References 10: 8 Russian, 1 Western.
[246-2415]

UDC 519.86

OPTIMAL SYNTHESIS IN PURSUIT GAME PROBLEM WITH SMALL PARAMETER

Moscow IZVESTIYA AKADEMII NAUK SSSR: TEKHNICHESKAYA KIBERNETIKA in Russian No 3, May-Jun 82 (manuscript received 26 Jan 81, after completion 2 Dec 81) pp 52-58

KORNEYEV, V. A. and MELIKYAN, A. A., Moscow

[Abstract] The differential game of two players, pursurer and evader, is considered as a problem of control in a conflict situation. Optimum control for each player is sought in dynamics describable by the equations

$\dot{x}_1= -x_2u+ \varepsilon\sin x_3$, $\dot{x}_2= x_1u- 1- \varepsilon\cos x_3$, $\dot{x}_3= -u + \varepsilon\gamma v$ ($|u| \le 1$, $|v| \le 1$, $x= (x\ ,x\ ,x\ )$ vector of phase coordinates, (x_1,x_2)- coordinates of evader in movable system, x_3- angle between velocity vectors of the two players, u- scalar control of pursuer, v- scalar control of evader, ε and γ positive constants). The game is finished when the distance between players becomes smaller than a given $R > 0$ and thus the phase vector falls within the terminal set $M=\{ (x_1,x_2,x_3):x_1^2+x_2^2 \le R^2,\ |x_3| \le \pi\}$. The pursuer strives to minimize the game time and the evader strives to maximize it, the payoff being the functional $J= \int_0^T 1dt= T$, $x(T) \in M$ (t- time). The pursuer's optimum positional control is determined through synthesis in the initial approximation, the evader's through synthesis in the first approximation. The respective problems are solved for $\varepsilon \to 0$ with aid of corresponding Hamiltonians. Their solutions are analyzed in respective phase planes, of particular interest being the trajectory (pursuer's) and the surface (evader's) where their control changes sign. The results apply qualitatively also to a small interval $0 \le \varepsilon \le \varepsilon_0$ and can be extended to a larger one. Figures 3, references 11: 7 Russian, 4 Western.
[231-2415]

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